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SOUTHWEST RESEARCH INSTITUTE ASSISTANCE TO NASA IN BIOMEDICAL AREAS OF THE TECHNOLOGY UTILIZATION PROGRAM

FINAL REPORT

Period Covered: 1 November 1967 - 30 November 1968

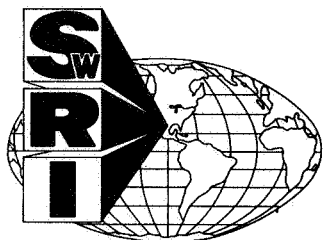
Contract No. NASW-1714
SwRI Project No. 14-2329

Prepared for

Chief, Dissemination Branch, Code (101)
Technology Utilization Division
Office of Technology Utilization
NASA

Washington, D. C. 20546

31 December 1968



SOUTHWEST RESEARCH INSTITUTE
SAN ANTONIO HOUSTON

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**Southwest Research Institute
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I.

INTRODUCTION

A. General

The aeronautical and space activities conducted by the National Aeronautics and Space Administration (NASA) are creating an impressive body of knowledge of great potential scientific and technological usefulness. In carrying out its congressional mandate to disseminate this information for ultimate benefit of the general public, NASA has engaged in an extensive publications program; in particular, publications under the auspices of NASA's Technology Utilization Division (TUD) are specifically aimed at expeditiously transferring NASA developments to the scientific and industrial community.

Special difficulties are encountered when it is attempted to transfer NASA-derived technology, by means of TUD publications alone, to scientists in the biomedical fields. These scientists are particularly overburdened by the copious amounts of published biomedical material; additionally, they are by and large unfamiliar with the language and symbology of the physical and engineering sciences. As a result, technology in physical science and engineering has often not been as effectively transferred to biomedical applications as it deserves to be.

The TUD's investigations of the chain of events leading to the introduction of new products, technological inventions, and methods into medical practice have suggested that the biomedical research teams at medical schools and similar biomedical research institutions play a key role in this process. New discoveries, introduced by these groups, tend to proceed naturally through stages of professional approval, manufacturing interest and participation, on to the level of the practicing physicians, bringing direct health benefits to the public. It would seem an attractive goal to introduce NASA-derived advances at the level of the biomedical research team, and thus to utilize the existing channels to the medical practitioner and his patients for effective technological transfer.

As a result of these investigations, NASA's TUD has developed a general methodology for the solution of this important and special technological transfer problem. Prominently included in this methodology was the establishment of several strategically placed Biomedical Application Teams consisting of appropriately cross-trained and broadly experienced physical and biological scientists. It is the task of the Biomedical Application Team to facilitate and improve the productive interaction between NASA centers and biomedical research teams. Emphasis is on interpersonal contact, in which the cross-trained members of the Biomedical Application Team form an active link between these two groups of scientists. A flexible system is

maturing in which both principal groups, NASA personnel and biomedical researchers, freely and effectively participate in mutually beneficial exchange of skills and knowledge.

B. Participating Personnel

The following scientists are participating in the program:

- Southwest Research Institute Biomedical Application Team
- Southwest Research Institute Personnel:
 - Ray W. Ware, M.D., Director
 - Louis S. Berger, Assistant Director
 - Raul San Martin, M.D.
 - Charles J. Laenger, Sr.
 - Robert J. Crosby
 - Chester A. Heath
 - Felix St. Claire

Special Consultant: Andre G. Buck (West Coast Institutions)

Key Coordinators at User Institutions:

- F. Hermann Rudenberg, Ph.D., Associate Professor,
Department of Physiology, The University of Texas
Medical Branch, Galveston, Texas
- Jack B. Johnson, Chief, Biomedical Instrumentation
Section, Southern Research Support Center,
Veterans Administration, Little Rock, Arkansas
- Mr. John Hall, Seattle Handicapped Center,
Seattle, Washington
- Mr. Don Baker, University of Washington, Department
of Bioengineering, Seattle, Washington
- Mr. H. A. Miller, Stanford University School of Medicine
- N. P. Thompson, M.D., Palo Alto Medical Research
Foundation
- Joseph Canzoneri, III, (SRS), Director, Biomedical
Engineering, Texas Institute for Rehabilitation and
Research, Houston, Texas
- V. Mooney, M.D., (SRS), Rancho Los Amigos Hospital,
Downey, California

Other Southwest Research Institute Staff consulted:

- Leon M. Adams, Ph.D., Manager, Organic and Polymer
Chemistry
- Wallace L. Anderson, Ph.D., Senior Research Engineer

Robert Bond, Ph.D., Senior Research Physicist
W. R. Brian Caruth, Ph.D., Manager, Operations Research
J. Wray Fögwell, Manager, Electromechanical Research
Gerald Gardner, Ph.D., Senior Research Physicist
Stephen Juhasz, Ph.D., Editor, Applied Mechanics Review
Ulric S. Lindholm, Ph.D., Manager, Solid Mechanics
M. A. Schrader, Research Engineer
Richard T. Mannheimer, Senior Research Engineer
Paul D. May, Senior Research Chemist
Frank C. Milstead, Senior Research Engineer

II.

PROGRAM DESCRIPTION - INSIGHTS GAINED

II. PROGRAM DESCRIPTION

A. Summary of Activities

Project work during the past contract period included the continued servicing of previously submitted problems from the older participating member institutions, as well as establishing relationships with, and processing newly submitted problems from, five West Coast institutions. Problem submission from both types of institutions followed the familiar pattern: when a new institution begins participating, there is a flurry of initial problem submissions. As the relationship matures, and the first layer of prominent problems is identified, activities shift to processing and follow-up of the submitted problems, with a marked reduction of new problem submissions. A total of 43 new problems was submitted, nine of these coming from the older institutions. On the submitted problems, a total of 27 searches was conducted.

The benefits of previous project experience yielded improved efficiency in achieving transfer: 18 transfers were accomplished, as reported in Section III.

A total of 33 visits was made to participating member institutions, four NASA Research Centers were visited, and six conferences were attended.

Three papers were presented, and one paper is currently in preparation, as reported in Section II. B.

B. Insights

During the first year of program performance, we repeatedly found that researchers and administrators at participating institutions had stereotyped misconceptions about the aims and the mechanisms of the NASA program. Staff members frequently believed the program to be essentially a literature search and information retrieval program; perhaps this misconception was engendered by some of the terminology which is commonly encountered during the program execution (e.g., words such as "information transfer," "technology transfer", "technology utilization"). The assumption also was sometimes made that the program would routinely furnish hardware upon request, and that its function was similar to that of a hardware surplus disbursing agency. It seemed indicated, in the light of these misconceptions, to emphasize in initial briefing interviews those things that the program was not primarily concerned, as well as describing the program function in positive terms.

The conclusions that were expressed in the last Final Report regarding thoughtful consideration of potential new problems were applied in communications

with the new as well as the older participating research institutions. To improve program efficiency, a number of problem areas of interest to newly participating researchers were prescreened, and the resulting information was furnished to these researchers as a guide to planning Problem Statement submission. The need for a careful approach to Problem Statement acceptance was also discussed at some length during briefing sessions with key administrative and research personnel at the new member institutions.

In the current project year, the following papers were presented:

- (1) Louis S. Berger, "Search Strategy and Communications Networks in the Biomedical Application Program, " presented at a conference on the Utilization of Space Technology in Mental Retardation Research, Manned Spacecraft Center, Houston, Texas, February 12-13, 1968.
- (2) Ray W. Ware, "The Insights into Applying Aerospace Technology to Medical Fields" presented at the Third Annual Meeting of the Association for the Advancement of Medical Instrumentation, July 15-18, 1968, Houston, Texas.
- (3) Louis S. Berger, "The Barriers - Communication Between Disciplines, " presented at the Third Annual Meeting of the Association for the Advancement of Medical Instrumentation, July 15-18, 1968, Houston, Texas.

A paper, "Interdisciplinary Dissemination of Aerospace Technology-- Holistic Approach, " by Mr. Louis S. Berger (accepted for presentation at the forthcoming Sixth Space Congress, March 17-19, 1969, Cocoa Beach, Florida) will contain further analyses concerning the information transfer process.

C. Operations Research Analysis and Evaluation

Evaluation of the process of technological growth is becoming increasingly necessary to help in the process of channeling this growth in desirable directions. That channeling or management of technological growth is realized in part from the increasingly ubiquitous influence of technology on society and the subsequent realization of the ramifications of uncontrolled technological growth. Understanding of the process of technological growth is a prerequisite to effective management.

The current contract provides an opportunity to analyse the growth of technology in biomedicine. The fact that the contract is a controlled effort to apply NASA-developed technology to biomedical problem does not detract from the significance of the results, nor from their contribution to improved understanding of the process of technological growth.

At the time data were collected for this first operations research analysis of the technology transfer process, relatively few transfers had been completed. As the number of submitted problems and completed transfers continues to grow so will the data base relevant to the transfer process, and the results of data analysis will become more meaningful.

A preliminary format has been developed for recording data relative to contract activities for analysis purposes. The analysis will consider each problem submitted and the transfer activities associated with each problem. These will be broken down into two broad categories:

- (1) The search for technical references pertinent to the problem
- (2) Technical communications associated with each problem.

Under the Search Category, data will be recorded for:

- (1) The number of references identified from the following sources:
 - (a) A computer search of NASA literature
 - (b) The personal knowledge of BAT personnel
 - (c) References identified from previous searches
 - (d) NASA literature surveys
 - (e) Dissemination of a Problem Abstract
 - (f) Technical communications (visits, telephone calls, letters, etc)
 - (g) Other sources.
- (2) The number of identified references for which further literature is requested.
- (3) Evaluation, by the Problem Originator, of the relevancy of the references to his problem.

Under the Technical Communications Category, data will be recorded for the number, sequence of visits, telephone calls, and letters with:

- (1) The Problem Originator
- (2) NASA search centers (WESRAC, KASC)
- (3) NASA Research Centers
- (4) Other individuals and institutions.

The success of the transfer activities will be recorded in four categories. These are:

- | | |
|----------------------------|---|
| (1) Directly Useful (DU) | Problem solved, technology successfully applied. |
| (2) Indirectly Useful (IU) | The immediate problem was not solved, but the technology identified solved another problem. |

- | | |
|-----------------------------|---|
| (3) Potentially Useful (PU) | Technology tentatively thought to solve the problem, but not confirmed through application. |
| (4) Not Useful (NU) | Problem unsolved. Transfer activities did not contribute to the problem solution. |

The status of the transfer activities at any time will be recorded in three categories. These are:

- | | |
|----------------|---|
| (1) Inactive | Transfer activities have been stopped, but problem has not been closed out. |
| (2) Incomplete | On-going transfer activities. |
| (3) Closed out | Closed-out problems must also be assigned to one of the four success ratings. |

Recording the data in this way will facilitate both the analysis of transfer activities over a particular time period and the analysis of transfer activities relevant to a particular problem. The objectives of the analysis will include:

- (1) Identification of factors and activities contributing to a successful transfer.
- (2) The relative contribution of factors and activities to the transfer process.
- (3) Exploration of the relationship between the contribution of the Problem Originator to the transfer process with the end result.
- (4) To the extent possible, development of a measure of the cost and effectiveness of various factors and activities to the transfer process.

The information developed through the analysis will be used to improve transfer procedures for executing the technology transfer process. The recorded data will also be useful as an administrative and management tool in the following ways:

- (1) To identify problems with a long history of inactive status.
- (2) To identify problems with incomplete status requiring management attention.
- (3) To assist in developing an optimal allocation of BAT resources to submitted problems.

Results of a Preliminary Analysis.

A preliminary analysis of problems submitted up to and including March 1968 was made. The factors and activities included in the analysis were:

- (1) Computer searches of NASA literature
- (2) Technical visits with Problem Originators
- (3) Technical visits to NASA Research Centers.

Only problems that had reached closed-out status were considered in the analysis. Twenty-eight problems were analyzed, and the following table was developed:

TABLE I

<u>Search</u>	<u>Problem Originator Visit</u>	<u>NASA Center Visit</u>	<u>Number of Problems</u>	<u>Success Rating</u>			
				<u>DU</u>	<u>IU</u>	<u>PU</u>	<u>NU</u>
No	No	Yes	1	0	0	1	0
No	Yes	No	1	1	0	0	0
Yes	No	No	6	3	0	1	2
No	Yes	Yes	6	3	0	1	2
Yes	No	Yes	2	1	1	0	0
Yes	Yes	No	9	4	1	1	3
Yes	Yes	Yes	3	2	0	1	0

Using this table, a second table was developed which shows the success ratings for possible combinations of the factors considered.

TABLE II

	<u>Number of Problems</u>	<u>DU</u>	<u>IU</u>	<u>PU</u>	<u>NU</u>
1. A Search <u>or</u> A Problem Originator <u>or</u> a NASA Center visit	8	4	0	2	2
2. A combination of any two factors	17	8	2	2	5
3. A Search <u>and</u> A Problem Originator visit and a NASA Center visit	3	2	0	1	0

Normalizing Table II to where each category has no problems yields Table III:

TABLE III

	<u>Number of Problems</u>	<u>DU</u>	<u>IU</u>	<u>PU</u>	<u>NU</u>
1.	100	50	0	25	25
2.	100	47	12	12	30
3.	100	67	0	33	0

This analysis must be considered as very preliminary, but Table III indicated a trend towards showing that the success rating of problems varies proportionally with the number of factors and activities included in the transfer process.

D. Projections

In addition to continuation of the Biomedical Application Team effort following methodologies proved effective in the past, the following projected activities are deemed worthy of mention.

To achieve the goal of reduction in cost/problem accepted, the Team effort of this past year will be analyzed by operations research techniques in order to arrive at appropriate modifications of SwRI Team operation and project methods and procedures. It is proposed to continue the operations research study of future effort on a quarterly basis, with a section of each Quarterly Report to be devoted to a review of findings as outlined in Section II. C of this report. Further improvements in the means of keeping track of significant categories of program expenditure will be adopted where appropriate.

The goal of achieving a broader base of support will be pursued by searching for complementary funding in the following ways:

- (1) Industrial subscriptions will be solicited for consultation service directed toward new project development in the field of medical instrumentation.
- (2) Funds will be sought through individual research grants where user project needs include biomedical engineering services. Efforts in this direction will be especially directed toward biomedical research institutions not presently involved in the Biomedical Application Program and institutions recently associated.
- (3) Collaborative agreements will continue to be sought from other government agencies on a cost-sharing basis.
- (4) Investigators with internal projects at Southwest Research Institute will be encouraged, where appropriate, to use the Biomedical Application Team's services on a pay-as-you-go basis.

Expansion of Biomedical Application Team activities will be attempted with the Sponsor's permission in order to test the methods developed in the in the NASA Biomedical Application Program to certain problems outside the biomedical research field. Such efforts will be directed toward other areas of recognized public need having a life science component, e. g., automotive safety technology.

Preparation of papers for proper dissemination of Biomedical Application Team technology developed under the program is anticipated, and attendance at meetings for the purpose of presentation of papers and/or scientific exhibits is planned.

III.
TRANSFERS

III. A

OUTLINE USED

In this section, actual transfers are reported according to the following outline:

TRANSFER IDENTIFICATION (TITLE)

1. THE PROBLEM
 - a. Statement
 - b. Source: Institution/Investigator
2. TRANSFER STATUS
3. SOLUTION
 - a. Synopsis
 - b. Method by Which Identified
 - c. NASA Source (Program/Field Center)
4. ESTIMATE OF BENEFITS AND COSTS
 - a. Actual Benefits
 - b. Potential Benefits
 - c. Cost of Solving/Saving (To Investigator)
5. PROGNOSIS/OTHER RELEVANT INFORMATION

III. B

TRANSFER REPORTS

Implanted Blood Pressure Transducer

1. a. A means for monitoring blood pressure of the rat on a long-term basis via an implanted transducer is required. Telemetry via wire line is acceptable.

b. F. H. Rudenberg, PhD
Associate Professor of Physiology
University of Texas Medical Branch
Galveston, Texas
2. Actual Transfer: Information on developmental pressure transducers supplied by the technical literature search enabled the investigator to survey the state-of-the-art. This saved the investigator's resources and accelerated application of the state-of-the-art.
3. a. The capacitance pressure transducer developed by Mr. Grant Coon at NASA-Ames would be applicable to this problem, although it is not presently available. A survey of other transducer developments indicates that suitable transducers are not available commercially.

b/c. The SwRI Biomedical Application Team was aware of the existence of the NASA-developed transducer. The technical literature search provided articles on this unit, and the TUD office at Ames provided additional information.
4. a. Search and survey time of the investigator was conserved.
Existence of suitable developmental transducer was revealed.

b. Application of a suitable pressure transducer could improve diagnosis and therapy of head injuries. This would result in the following:
 - (1) Reduction of recovery time
 - (2) Degree of recovery (Reduction of incapacitation)
 - (3) Saving in lives.
c. Inestimable savings in money, time, and lives could result from research and development work and clinical use of a suitable transducer.
5. The investigators, like many others, are awaiting commercial availability of the NASA capacitance transducer.

Chronic Intracranial Pressure Measurement in Man

1. a. Injury to the central nervous system often results in swelling of this tissue which can cause serious reduction of blood perfusion resulting in brain damage. Smaller and better transducers for measuring intracranial pressure are needed.

b. F. H. Rudenberg, PhD
Associate Professor of Physiology
University of Texas Medical Branch
Galveston, Texas
2. Actual Transfer: Information on developmental pressure transducers supplied by the technical literature search enabled the investigator to survey the state-of-the-art. This saved the investigator's resources and accelerated application of the state-of-the-art.
3. a. The capacitance pressure transducer developed by Mr. Grant Coon at NASA-Ames would be applicable to this problem, although it is not presently available. A survey of other transducer developments indicates that suitable transducers are not available commercially.

b/c. The SwRI Biomedical Application Team was aware of the existence of the NASA-developed transducer. The technical literature search provided articles on this unit, and the TUD office at Ames provided additional information.
4. a. Search and survey time of the investigator was conserved. Existence of a suitable developmental transducer was revealed.

b. Application of a suitable pressure transducer could improve diagnosis and therapy of head injuries. This would result in the following:

 - (1) Reduction of recovery time
 - (2) Degree of recovery (Reduction of incapacitation)
 - (3) Saving in lives.
c. Inestimable savings in money, time, and lives could result from research and development work and clinical use of a suitable transducer.
5. The investigators, like many others, are awaiting commercial availability of the NASA capacitance transducer.

A Model Vascular System

1. a. Information on materials and techniques for fabricating an artificial vascular system is needed. A satisfactory model would be most useful to the investigator in radiographic studies.

b. Robert N. Cooley, MD
Professor and Chairman, Department of Radiology
University of Texas Medical Branch
Galveston, Texas
2. Actual Transfer: References supplied by NASA have proved valuable in making the investigator aware of the state-of-the-art in this area. This has conserved the investigator's resources and has accelerated application of the available knowledge; however, the investigator is not able to continue work at the present time due to lack of resources.
3. a. Literature search results were obtained, screened, and supplied to the Problem Originator, who reviewed and evaluated the information. A document entitled "Final Report on Mock Circulatory System" proved to be of significant value to the investigator.

b. Information which would serve as a valuable basis and background to the researcher was acquired through a literature search performed by KASCenter.

c. The NASA Biomedical Application Team supplied technical information. The most valuable reference, cited above, was a product of work that had been funded by NIH.
4. a. It is inappropriate to discuss the actual and potential benefits of the efforts of the Biomedical Application Team because work on the project has been suspended.

Computer Program for Electroencephalograph: Period Analysis

1. a. Electroencephalographic records are used in diagnosing the nature and extent of head injuries. But the EEG would be used much more extensively if better and faster means for analyzing the data were to be provided.

b. F. H. Rudenberg, PhD
Associate Professor of Physiology
University of Texas Medical Branch
Galveston, Texas
2. Actual Transfer: A technical literature search was performed, and the technical information requested by the investigator was supplied by the Biomedical Application Team. This material was useful in preparation of a grant application to NIH for work in head injury diagnostic research.
3. a. Research concerning sleep patterns of animals following head injury has been in process for the past 2 years in the investigator's laboratory. One of the problems which restricts the use of EEG information is that of data handling. It is felt that this function could be performed better, faster, and more economically via computer techniques.

b. The researcher submitted a problem statement from which the Biomedical Application Team wrote a technical document computer search statement. The search results were screened and sent to the researcher for review of the abstracts. Complete articles were supplied for appropriate references.

c. The most helpful information has come from the work of Dr. W. Ross Adey, at the U. C. L. A. Brain Research Institute, whose development of EEG pickup helmets, telemetry, and computer analysis has been in collaboration with the NASA Mercury, Gemini, and Apollo Applications programs.
4. a. Knowledge of this work by Dr. Adey has helped Dr. Rudenberg apply the state-of-the-art in EEG pickup, telemetry, and computer analysis in his grant application for support of the Head Injury Research Center at the University of Texas Medical Branch in Galveston.

b. Initial savings would be in technician's time. Ultimately, computer EEG analysis would improve patient care and monitoring, aid in evaluation of therapeutic drugs and procedures, and reduce the length of hospitalization for head injury victims.

- c. It is estimated that 50% of a technician's salary can be saved per year, a greater number of experiments can be processed and analyzed, and the computer operation will be more accurate, reliable, and attain an improvement in pattern recognition.
- 5. Continuation of the work is contingent on the approval of a grant for support of the Head Injury Research Center.

Computer Program for Flame Spectrophotometry

1. a. The investigator uses a flame photometer to analyze the mineral content of tissue samples from patients and from experimental animals. The various ions interact with each other so that the brightness of light emitted at an ion's characteristic wavelength is not only related to the concentration of that ion but also to the concentration of other interfering ions. Present techniques require frequent calibrations with standard solutions, a tedious and time-consuming operation. The investigator requested a computer program which would take into account the nonlinear calibration and ionic interference, and interpret the flame photometer readings directly in terms of mineral concentrations.

b. Dr. F. Hermann Rudenberg
Associate Professor
The University of Texas Medical Branch
Galveston, Texas
2. Actual Transfer: Investigator is analyzing the solution to confirm its correctness and to assess the difficulty of its application.
3. a. A computer program for obtaining the general solution of several sets of simultaneous nonlinear equations was found in the COSMIC computer program bank.

b. A Senior Research Engineer at the Southwest Research Institute analyzed the problem while preparing a Problem Abstract. A suitable program was found in COSMIC.

c. COSMIC
4. a. Dr. Rudenberg will apply the state-of-the-art in computer analysis to solving problems of chemical analysis.

b. Dr. Rudenberg could save approximately 25% of a technician's salary per year, and the results of chemical analyses could be obtained more rapidly and with greater reliability. The technique is quite general and should be of benefit to users of flame photometers throughout the medical community.

c. Dr. Rudenberg will spend about 1 week in evaluating and instituting the procedure. Also required will be 3 days of a computer programmer's time and 2 weeks of a laboratory technician's time to make and to run the standard solutions.

Computer Selection and Elimination of Artifacts

1. a. The EEG records of monkeys subjected to psychologically active drugs serve as objective measures of the effectiveness of the drugs. These records are disturbed by artifacts resulting from the electrical events associated with contraction of heart (EKG) and skeletal muscle (EMG). Skilled technicians can visually detect and reject the more obvious artifacts. The investigator hopes to analyze the EEG records automatically with an on-line digital computer, and he needs a program or technique which will enable the computer to recognize and ignore artifacts without the aid of human intervention.

b. Behavioral Science Laboratory
The University of Texas Medical Branch
Galveston, Texas
Dr. Colin G. McDiarmid
2. Actual Transfer: Dr. McDiarmid has been reassured that he is applying the present state-of-the-art in computer identification of artifacts to his biological problem.
3. a. The solution has not been found.

b. KASCenter search of NASA data banks.
4. a. The NASA data banks have been searched for Dr. McDiarmid, and he now knows that there are presently no better methods than those he has been using.

b. If Dr. McDiarmid spends more time developing an artifact recognition program, he can be sure that he is not wasting time in duplicating a preexisting solution.

c. Dr. McDiarmid spent about 2 man-days evaluating the results of the KASCenter search.
5. This problem has been closed out.

Multiple Cospectral Density Analysis
of Time-Series Data

1. a. The investigator needs mathematical techniques which will permit representation of the time-series data obtained while measuring electrical potentials in various portions of the brain. He hopes to show by these analyses that a part of the brain called the amygdala is involved in control and inhibition of gross movement.

 b. Behavioral Science Laboratory
 The University of Texas Medical Branch
 Galveston, Texas
 Dr. Colin G. McDiarmid
2. Actual Transfer: The investigator's resources have been saved by avoiding his duplicating the development of existing mathematical analysis techniques. The state-of-the-art in analysis of random data developed for other fields has been applied more quickly to solving biomedical problems.
3. a. The solution lies in the use of mathematical techniques found in Chapter 3 of Bendat & Piersal's book, "Measurement and Analysis of Random Data."

 b. Mr. Floyd S. Shipman at the NASA-Langley Research Center read the Problem Abstract and suggested the Bendat & Piersal book.

 c. Langley Research Center
 Mr. Floyd S. Shipman
4. a. The investigator's resources have been saved by avoiding the duplication of the development of existing mathematical analysis techniques. The state-of-the-art in analysis of random data developed for other fields has been applied more quickly to solving biomedical problems.

 b. Computers offer the only logical way in which such complex interrelationships between voltages at different parts of the brain can be analyzed. Many thousands of patients per year could be returned to productive lives if the correct psychologically active drugs can be found and their action evaluated by these techniques.

 c. Dr. McDiarmid spent approximately 2 man-days evaluating the search returns and the solutions to the Problem Abstract.
5. This problem has been closed out.

Respiration Volume and Rate Measurement in
Unencumbered (Free) Children

1. a. Measure the rate and depth of respiration of burned children without touching their bodies and without connecting air tubes to their throats. The investigator will attempt to correlate respiratory ventilation with biochemical changes in the lining of the respiratory system and with blood gas analyses. The objective is to improve care and to speed rehabilitation of the burned child.

Present methods are unsatisfactory because they produce both pain and infection from touching the burned child's body and they increase the airway resistance and thus the respiratory effort.

- b. Shriners Burn Institute
The University of Texas Medical Branch
Galveston, Texas
Dr. Roy D. Wilson
2. Actual Transfer: Dr. Wilson's resources were conserved because he was able to avoid duplicating research done by the NASA Electronic Research Center on noncontacting means for measuring respiration.
3. a. A complete solution has not as yet been found. A prototype of a respirometer developed at NASA Electronic Research Center, which shows some promise of being adaptable to the problem, will be made available to Dr. Wilson for his evaluation.
- b. A Biomedical Application Team member made an orientation visit to NASA Electronic Research Center and identified their respirometer as a possible solution to the problem.
- c. Electronic Research Center
Dr. William Leavitt
4. a. Dr. Wilson was saved the time and money of duplicating NASA Electronic Research Center research.
- b. If the prototype respirometer proves to be usable for Dr. Wilson's purposes, he can devote his time to making minor modifications in the system without having to start from the beginning. He may obtain a system which is more accurate and reliable because it represents more research, development time, and money than he could afford to spend on his project.

- c. Dr. Wilson will probably spend 3 weeks of both his and a technician's time in evaluating the prototype respirometer.
- 5. If Dr. Wilson's evaluation is favorable, the respirometer can be copied for far less than its development cost and will substantially advance the treatment of burned children.

Respiratory Gases Measurements

1. a. The investigator requires a system which will analyze and telemeter the instantaneous flow rate and concentration of oxygen and carbon dioxide of the air exhaled during the exercise of children having heart disease.

b. Dr. Quang X. Nghiem
The University of Texas Medical Branch
Galveston, Texas
2. Actual Transfer: The researcher's application to the National Institutes of Health was approved but not funded. When he obtains financial aid, he will be able to apply the knowledge of the state-of-the-art in gas analyzers which the Biological Application Program helped him to obtain.
3. a. The complete solution has not been found, but several oxygen and carbon dioxide sensors developed for NASA are being considered by the investigator. None is completely satisfactory from the standpoint of cost, availability, and portability. A space helmet modification for respiration analysis, uncovered by the Midwest Research Institute Biomedical Application Team, will be used to allay the apprehension and excitement engendered in children when they are connected to conventional respiration analyzers.

b. The state-of-the-art gas analyzers which most nearly fulfill the researcher's requirements were identified by a WESRAC search of the NASA data banks, a consideration of manufacturers' literature, and a consultation with the key coordinator.
4. a. The investigator was aided in applying the state-of-the-art in gas analyzers to his grant request to NIH.

b. If the investigator's research is funded, the NASA sponsored gas analyzers will be applied to assessing the condition of from 100 to 150 children per year. This will enable the physicians to diagnose the conditions and recommend surgery with improved certainty.

c. The cost to the investigator cannot be estimated as yet because the final solution is not known.

Investigations of Cutaneous Stimuli

1. a. Information about cutaneous stimuli was requested which was in connection with studies of their utilization as an auxiliary sensory input channel. Electrical (amplitude and/or frequency modulated) and mechanical (vibratory, acoustic, etc.) stimuli are being investigated. Data are desired (for the sense of touch) on the thresholds of pain and perception, sensitivity to the information-bearing parameter, and also on devices which simulate the tactile sense. One application of this work is that to patients with damaged or destroyed sensory nerves.

b. Southern Research Support Center/E. A. Pfeiffer, PhD
2. Actual Transfer: Two research projects were stimulated by the search results returned to the Problem Originator; and a third existing project was materially aided.
3. a. The literature search results provided the background and stimulus for additional work in this problem area.

b. Search of NASA data bank.
4. a. The literature search of the NASA information stores resulted in the Problem Originator's instituting an exhaustive literature search at a 2 man-month level. The combined results of these two searches indicated to the researcher the desirability of performing laboratory research on shock parameters; work was implemented at a 6-man-month level of effort. A publication of results is being planned.

b. An independent project entitled "Electronic Conditioning Device for Smokers" was materially aided by the information generated in the problem area by the Problem Originator. This latter project, which was instituted at a 12-man-month level of effort, was proceeding very slowly because of inadequate information available to the researchers. Upon receipt of the information generated in the preceding two projects, the solution was materially aided. Volunteer testers of the devices produced by the latter project have contributed 4 man-months of voluntary effort to date. The effectiveness of the device critically hinged on parameters of "chronaxie" and "rheobase" which were reported with adequate detail in the searched literature.

c. In the case of the Problem Originator's activity, had the Biomedical Application Program not been available to him, it is possible

that the undertaken research would not have been initiated. Concerning the third research project, the smoker conditioning device, it is quite possible that this project would have been judged to show lack of promise, and would have been abandoned, barring availability of information furnished by the search which demonstrated that such a device had good potential.

5. The projected use of the Problem Originator's results is difficult to assess, since in his organization information is casually disseminated to a number of investigators in a way which makes transfer of information difficult to document. As to the smoker conditioning device, it is estimated that it is likely that this device will be used in Veterans Administration Hospitals. Commercialization of this device is also being considered, although the possibility of commercial development is in its initial talking stages. The two literature searches which seeded this area of effort are: A66-81537, "Electrocutaneous Pain Thresholds in Humans to Low Frequency Square-Wave Pulses," Robert Plutchik and Henry Bender, Journal of Psychology, Vol. 62, March 1966, pp. 151-154, ref. Contract Nonr-2252(01); and A66-81664, "Some Factors Influencing the Threshold of the Electrocutaneous Stimulus," James Sheridan, Emerson Foulke, and Earle Alluisi, Perceptual and Motor Skills, Vol. 22, April 1966, pp. 647-654, 13 refs., Contract DA-49-193-MD-2525.

21 November 1968

A technical paper entitled "An Automatic Electronic Device Used in Aversive Conditioning of Cigarette Smokers" was presented by Mr. Jack Johnson at the 21st Annual Conference on Engineering in Medicine and Biology. This presentation included those results achieved to date.

NOTE: The body of this Transfer Report is reprinted from the preceding Final Report; an up-dating entry has been added.

Acquisition and Telemetry of Heart Rate, Blood Pressure,
and Blood Flow in Free-Ranging Dogs

1. a. An economical means for telemetering heart rate, systolic and diastolic blood pressure, and blood flow in free-ranging dogs is required. The transducers should be implantable, and the telemetry package should fit in a suitable backpack. Range should be 1/4 mile, and battery life should be 1 week.

b. Veterans Administration Psychiatric Hospital
Joseph E. O. Newton, MD
2. Actual Transfer: Information and consultation provided by the Biomedical Application Team enabled the researcher to select a method whereby he can acquire and telemeter physiological information from free-ranging dogs. He decided to phase this effort with work in progress at other facilities. He is now in a position to plan and to design-modify a data acquisition and wireless telemetry system for his particular application.
3. a. Results of previous literature searches and of updated searches on biotelemetry were supplied by the Biomedical Application Team. Information on blood pressure and blood flow velocity transducers was previously supplied to the key coordinator, Mr. Jack B. Johnson, who is a competent biomedical engineer at the Veterans Administration Hospital and who is assisting these researchers. The Biomedical Application Team visited the researcher's facilities where the experimental work is in progress. During this visit, instrumentation techniques and literature search strategy were discussed. The Biomedical Application Team suggested that the researcher visit the Biodynamics Laboratory at Brooks Air Force Base where extensive work involving surgical implantation of ultrasonic transducers for measurement of blood flow velocity is being performed. Dr. Newton and Mr. Johnson subsequently visited the Brooks AFB laboratory and the Medical Instrumentation Section laboratory at SwRI where special catheter tip transducers are currently being developed.

b. The researcher decided to use the ultrasonic Doppler approach for measuring blood flow. This decision resulted from consideration of biotelemetry and transducer information supplied by the Biomedical Application Team, consultation and visits suggested by the Biomedical Application Team, consideration of commercial equipment brochures, and consultation with the key coordinator.

4. a. Literature and consultation provided, and laboratory visits suggested, by the Biomedical Application Team enabled the researcher to reach decisions on the approach that he would pursue. This permitted the research to go from a system survey phase to a system design-selection-modification phase. The researcher's ultrasonic Doppler flowmeter work will parallel similar work presently in progress at other facilities.
- b. Development of a means for acquiring valid physiological data from free-ranging dogs will enable the researcher to determine if certain physiological parameters of "nervous" bird dogs are correlatable with their nervous condition. Proof of such correlation would justify further work with humans. Eventual correlation of mental disease with physiological parameters in humans could be, indeed, an enormous breakthrough.
- c. It is not known how long Dr. Newton and his associates would have continued initial system survey before selecting an approach. Assistance by the Biomedical Application Team substantially aided the researcher. Dr. Newton and Mr. Johnson are continuing their review and consideration of biotelemetry systems.

Exercise Device for Handicapped or Confined Patients

1. a. The problem involves the finding, utilization, and/or improvement upon static human exercise devices suitable for use by confined persons. Such confinement might be in a bed, in a wheelchair, or might pertain to persons with limited muscular-skeletal range and locomotion. The Problem Originator had seen a NASA national TV release of exercise program and equipment for astronauts in orbit, with no identification of specific equipments.

b. Northwest Institute for Rehabilitation and Research
Mr. John H. P. Hall
2. Actual Transfer: Equipment has been identified through NASA channels. Information has been forwarded to the Problem Originator, who plans to use such for both research and clinical programs.
3. a. The Problem Originator's direct approach through NASA Technology offices was unproductive, since the request was phrased in the terminology of NASA development. Subsequent search by the Biomedical Applications Team determined that NASA had selected a commercial product. NASA-MSD identified this source, the information being subsequently relayed to the Problem Originator.

b. Consultations between Dr. R. W. Ware, of SwRI, and Dr. A. D. Catterson, Deputy Director of Medical Research and Operations, NASA-MSD, established the identity of the required equipment as the "ExerGenie", a commercially available device.

c. Apollo program/Manned Spacecraft Center/Dr. Catterson and Mr. J. Wheeler (TUO-MSD).
4. a. Mr. Hall would, most probably, have eventually found the same problem answer as that found through the services of the Biomedical Applications Team. He states that he would have written the television-program-director, and would have then made such successive contacts as were necessary to succeed in making the authoritative contact.

b. Mr. Hall points up rather imposing potentialities of this technology. First, the availability of physical therapists is very limited; the number of patients that can be served is correspondingly limited. The use of the subject exercise device, as an extension of the therapist's services, in the home as well as in the hospital, (1) will permit the therapist to serve more patients, (2) will expedite the

recovery of patients, and (3) will permit patients to become, more rapidly, productive members of society.

- c. Minor modifications will be required for patient usage. It is estimated that 4 man-months' time may be required. Were the complete design to be developed, tested, and modified, it is estimated that at least 4 man-years could be involved.
5. If after modification and test the exercise gear meets the Problem Originator's expectation, units will be employed not only in the Rehabilitation Services but also in each of the patient's homes as well. Approximately 300 patients per year in the Seattle area will benefit from this technology.

Early Detection of Vestibular Unbalance in Children

1. a. It is believed that early detection of vestibular, or other, unbalance in children can lead to corrective treatment. Failure to recognize this condition, which is frequently evident only upon precise measurement, can lead to a situation when corrective effort is no longer effective; it is too late.

Precise measurement of toe and heel pressures of each foot (feet being first in parallel, then heel-to-toe), both statically and dynamically, are required. Second, since we are dealing with children, an inducement or "reward" is necessary so that they will be motivated to do their best to maintain balance.

- b. Stanford University School of Medicine, Department of Pediatrics, Dr. Reuven Kohen-Raz.
2. Actual Dual Transfer: The historically established expertise of the NASA, particularly in the field of aeronautical research instrumentation, was called upon to recommend the most direct and fool-proof method of instrumentation. The NASA-developed wind-tunnel force-balance techniques, now commercially available, seemed best. The Problem Originator has followed this recommendation, and the force-measuring equipment will be in hand on December 1.

The second element, "reward", called upon NASA experience in the aeronautical-astronautic research field of audio-visual presentation. Analysis, definition, and recommendations were made. In addition, NASA-Ames is undertaking the loan of certain commercial equipment, parts of a system, to the Problem Originator.

3. a. The Problem Originator first approached the Ames Research Center (Dr. Eric Ogden, Chief of the Environmental Biology Division, who recognized the problem as within the scope of the NASA-Biomedical-Assistance-Program). A referral to the Biomedical Team led to problem discussion, further NASA detailed area-discussion, recommendation, and solution.
- b. The problem areas were recognized by the Biomedical Team as being within the experience-extrapolation of NASA. Consultations with NASA led to direct recommendations, loan of equipments, and system solution.

- c. Aeronautics & Astronautics, Ames Research Center
 - (1) Messrs. Dimeff, Rositano, Kolbe--Instrumentation Division.
 - (2) Mr. DeVoto (Graphics & Presentation)--Technical Information Division.
- 4. a. Dr. Kohen-Raz, the Problem Originator, has stated that the research program, accurately instrumented, must be performed within 1 year, on a very modest budget. The objectives of equipment selection/design/manufacture/utilization for a specialized research program have been achieved through the use of NASA expertise within a period of 60 days. It is estimated that no less than 12 professional man-months have been saved. A program was initiated that otherwise might not have been feasible.
- b. It is believed that this research is unique in that it has never been performed before with scientific accuracy. However, it is known that significant numbers of afflicted adults, whose condition might have been corrected by early therapy, do exist. The productive use-loss is estimated to be high.
- c. The time factor: were it not for the NASA assistance, this research could have been delayed to the point of incompleteness within the 1 year's time allowed. A 3-man-hour expenditure of NASA's time, coupled with the Biomedical Team's effort, has helped to bring the program to the "go" stage. Secondly, the experimentalist's budget of \$1000 for equipments, it is estimated could not have been met by a commercial approach by at least one order of magnitude.
- 5. Research will begin in December. It is expected that initial screening of literally dozens of children will be complete by mid-1969. Follow-up screening is expected to be of a clinical examination nature, akin to chest X-rays or audiometry. It is estimated that from 150 to 200 patients, in the local population of one-half million, may benefit each year by early diagnosis.

Measurements of Kinematic and Dynamic Parameters
in the Handicapped Patient

1. a. This problem requires the acquisition of more accurate and meaningful pressure/shear data from the paraplegic or hemiplegic patient during foot-floor impact, and telemetering this information to a central terminal.

Objective assessment of a patient's state of ambulatory disablement by analysis of his gait can lead more readily and accurately to proper treatment, and will assist in the re-learning process.

- b. Rancho Los Amigos Hospital
Dr. Jacquelin Perry, Chief of Kinesiology.
2. Actual Transfer: Tech Briefs; complete backup packages; actual pressure-cell loan for test; and two specially constructed pressure cells have been furnished to the investigator. Pressure cells are of NASA origin and development.
3. a. Following problem submission, the Problem Originator was furnished results of previous pressure-cell searches. Shortly thereafter, the Biomedical Team noted a new Tech Brief No. 68-10246, which had been handed to the Problem Originator. Since NASA-NAR is also located in Downey, California, liaison was effected between the researcher and the pressure-cell manufacturer. From this point, the principals have dealt directly with each other, with gratifying cooperation and results.
- b. The awareness of the Biomedical Team to the requirements of the submitted problem pin-pointed the potentially useful Tech Brief. Close cooperation between Rancho Los Amigos and NASA-NAR carried this potential to fruition.
- c. Apollo Program/Manned Spacecraft Center/Mr. Clayton McDonald. Much credit must be given to North American Rockwell for their cooperation and sympathetic understanding of the Rancho Los Amigos problem.
4. a. Pressure transducers have historically been a backbone of NASA/NACA research. Mr. Daniel Antonelli, Research Associate of the Rancho Los Amigos Hospital, states that this "know how" has been of service in helping him to make proper selection. The actual working transducers are invaluable, he believes, in establishing

the Rancho Los Amigos' position for a research grant from other Federal agencies.

- b. The research proposed is believed to be unique. Pressure transducers mounted in the patient's shoes, with lightweight telemetry transmission of information, will permit measurement of patients' walking pressures without restriction of fixed floor-plates, etc. Walking on the level, up stairs, and on inclined planes becomes possible. By comparison with norms, early training and other corrective effort may be applied. It is thereby hoped to return patients to productive enterprise at early dates and to save both time and cost of this relearning process. There is reason to believe that, if successful, the procedures could become available to all amputees, recovering stroke victims, etc. The numbers are imposing.
 - c. The prime contribution of NASA has been to clarify problems, pin-point solution methods, thus permitting Dr. Perry-Mr. Antonelli's research to proceed expeditiously. The recognition of cost economy in the above is an important factor. Approximately 1 year's time in the development of the research has been saved; the investigators are on firm ground, both technically and economically.
5. Dr. Perry and Mr. Antonelli have prepared the required grant application, which has been forwarded to the proper Federal authority. If subject grant is approved, research should be well underway within the year. Results, methodology, and special techniques should be available to all rehabilitation units shortly thereafter. The key at the moment is the research grant; NASA has pointed the way. Presently, a pilot research study is in progress in-house, and some funding may become available from the USC R & R Center to further this work.

Acquisition and Telemetry of Whole Body
Kinesiology in Handicapped Patients

1. a. This problem, which completes the instrumentation system of RNV-10, involves the telemetry of the foot pressure/shear data to be obtained under RNV-10, plus telemetry of whole body kinesiology of walking-handicapped patients. A maximum of 30-channel telemetry is involved.

b. Rancho Los Amigos Hospital
Dr. Jacquelin Perry, Chief of Kinesiology
2. Actual Transfer: In this instance, the established expertise of NASA/NACA of telemetry in aeronautics, astronautics, and life sciences was called upon to analyze, define, and recommend telemetry compatible with the medical and economy requirements of the Problem Originator. This involves not only knowledge of other's work, but also of developments completely NASA-in-house in nature. The transfer of such knowledge, with precise recommendation, has been effected.
3. a. Commercial recommendations had been far too expensive, and were also contradictory and diverse to the point of prohibition of further effort in this field. NASA-suggested methods of economy and simplification have reinstated this research program on a solid, completely defensible, economical basis.

b. The problem was presented to NASA-Ames on a basis of research requirement and of practical economy. Such factors were well known, were understood, and were acted upon with dispatch. NASA-developed implantable telemetry-transmission, with commutation (for economy), was suggested and accepted, following demonstration, as a design guide.

c. Life Sciences Program/Ames Research Center/Messrs. John Dimeff and Thomas Fryer.
4. a. The NASA contribution reinstated a research program, completely compatible with research objectives, that appeared to be economically impossible by conventional commercial practice, i. e., \$100,000 for telemetry alone. A five-fold reduction in price permits the research to continue.

b. Conservatively, the Rancho Los Amigos Hospital, if their research grant is approved, may expect to treat no less than 30 patients a

year. If the recovery process is expedited by only 1 month, a savings of \$25, 000 per year may be expected from this one, albeit large, hospital.

- c. A most worthwhile research program has been salvaged and returned to healthy activity because of engineering-economic appraisal. It is difficult to put a dollar figure upon this, but a conservative one is that at least 1 year's time, and at least \$10, 000 of the (short-range) Research Associate's time have been saved.
5. NASA-transferred technology permits a research grant to be considered. If the grant is made, the research and rehabilitation will proceed expeditiously. Assuming that the research is successful, and that a useful system results, it is estimated that the Rancho Los Amigos Hospital will use such on an average of ten patients per week.

Temperature Regulation in Congenital Amputees

1. a. Human skin, especially that of the extremities, serves, in addition to other roles, as a cooling surface area in allowing excess body heat to dissipate to the atmosphere.

When extremities are absent, the heat dissipating surface area is greatly reduced. This is particularly significant in children born with missing limbs.

Ways are sought by which to keep these handicapped persons cool under all atmospheric conditions, even without the use of an air-conditioned environment. The method of cooling must not be restrictive and must allow freedom of movement.

- b. Rancho Los Amigos Hospital
Alice Garrett, MD
Chief, Cerebral Palsy
2. Actual Transfer: In the first problem discussion with the Problem Originator, it became apparent that the liquid-cooled undergarments worn by astronauts would provide an ideal research vehicle. All that is required, in addition, is a simple and inexpensive water-temperature regulating system. A direct request to NASA-MSC produced the required suit, on loan, and this is now in the investigator's hands.
3. a. The problem posed by the investigator required a temperature-controlled environment, no mobility restriction, inexpensive manufacture, and one simple and economical to maintain. Little was known, however, of the engineering/thermal requirements. The research use of the astronaut's equipment permits simple and economical, as well as accurately measured, instrumentation and flow control to develop the required parameters. Further, by proper manifolding, it is possible to achieve selective and variant cooling to various parts of the torso as required. From the research data developed, it will not be difficult to translate into the final working units. The immediate and complete cooperation of NASA-MSC was obtained.
- b. The Biomedical Team knew of the problem requirement, and also of the existence of the cooling garments. Upon explanation of the NASA technology, the Problem Originator agreed to evaluate it and requested the loan.

- c. Apollo Program/Manned Spacecraft Center
Mr. Paul E. Purser
Special Assistant to the Director
- 4. a. It is believed that two immediate benefits are present: First, a research program has been expeditiously initiated. Second, costs, which might otherwise have required a grant, have been kept at an absolute minimum. A potential third element also exists--the investigator will have in hand solid engineering-support data for a follow-up program research grant.
- b. The obvious, and stated, goal is to provide a comfortable environment for a great many unfortunate, disabled children. There is more to this problem than comfort alone. The ability of the children to progress educationally with their class, and their earlier attainment of productive-ability; the possible extension to adults, with increase of productivity; and the economics involved nationally, are all important potential benefits.
- c. Since research can start immediately, it is estimated that at least 1 year's time has been saved. Since to selectively determine body-area cooling requirements more than a mere air-conditioned room is required, it is estimated that perhaps \$10,000 or more has been saved in research equipment costs.
- 5. This research program will rapidly acquire the data required, and commercially available products based upon this research may follow. In addition, and of great importance, is the stimulation of further research.

Automatic Breathing Monitor for Intubated Patients

1. a. Tracheotomies, requiring insertion of breathing tubes, seem to be very common, but are particularly frequent in infants and in children. In each case, and most especially so in the case of children, an unremitting vigil must be maintained to be certain that the breathing-tube never becomes mucous-clogged, or a catastrophe may result.

b. Rancho Los Amigos Hospital
Claire Stiles, MD
Chief Anesthesiologist, Department of Pediatrics
2. Actual Transfer: Full construction details on the NASA-Ames Research Center "Automatic Patient Respiration Failure Detection with Wireless Transmission", Tech Brief No. 68-10365 with backup package, have been furnished the Problem Originator. The above is sufficiently detailed so that any competent electronics technician can reproduce the technology with little potentiality of trouble.
3. a. Dr. Stiles, in connection with a prior problem (RNV-13) having to do with laryngoscopes, has been most gracious in explaining problems of infant tracheotomy to the Biomedical Team. This requirement knowledge, coupled with knowledge of the NASA-Ames developments, is considered fortuitous. Logical extensions to the Ames-developed implantable-telemetry equipment have permitted rather minor modification requirements in this problem area for solution. Identical equipment has been in use, and tested, at the Children's Hospital in Oakland.

b. The correlation of the research investigator, the NASA development group, and the Biomedical Team, has, in this problem, been most effective in recognizing, evaluating, and solving a matter of considerable importance.

c. Life Sciences Program/Ames Research Center/Messrs. Dimeff and Pope of the Instrumentation Division.
4. a. This problem has immediate clinical application. Dr. Stiles has indicated the urgency of subject equipment for usage in intensive-care units. Human (ICU) monitoring, no matter how carefully performed is subject to human frailties. The NASA contribution is not intended to be a substitute for doctor/nurse surveillance but, rather, an assist to this team, a backup.

- b. Dr. Stiles believes that such equipment may be invaluable in any ICU. Whether for infant, child, or adult usage, the application must be considered widespread, potentially. Also, the equipment is equally adaptable for both tracheotomy or completely normal-breathing monitoring, as well as alarm.
 - c. It is conservatively estimated that, if one were to start from an inception, development costs of similar equipment would approximate \$25, 000, on a nonprofit basis, as a minimum.
5. The technology transfer, in answer to Dr. Stiles' problem, is complete. Rancho Los Amigos has already taken in-house steps to reproduce the NASA-Ames device. As a minimum, this hospital performs from 100 to 150 tracheotomies per year. Monitoring in surgery and in Intensive Care Units is a must. Further, many cases are of long-time nature and require respiratory monitoring in the wards.

THE FOLLOWING TRANSFER REPORTS ARE
REPRINTED FROM THE SECOND
QUARTERLY PROGRESS REPORT,
JULY 1968

Operating Parameters for Lightweight, Extended Range,
Biomedical Telemetry Systems

1. a. The problem requires a lightweight telemeter system, to be worn by human subjects, to transmit biomedical information. The problem is complicated in that information transmission must be effective over rather large areas in a reinforced concrete building, room-to-room, floor-to-floor, and down corridors at distances of up to 800 feet.

b. Seattle Handicapped Center
Dr. Arthur W. Guy
2. Actual Transfer: Tests of recommended frequencies and equipment have been made and have proved satisfactory. The important point was to prove that effective radio transmission in subject environment could be accomplished. This has been done, and the problem is considered solved. The follow-up instrumentation may require further problem consideration.
3. a. NASA had previously made an exhaustive study of effective radio transmission in and through wind-tunnel passages and walls, and in and through reinforced concrete multistory buildings. Technology gained directly helped to answer Dr. Guy's problem.

b. The solution was identified by knowledge of NASA study on the part of the Biomedical Team's Special Consultant. This knowledge was verified by consultation with the NASA Chief Investigator. No report was prepared by NASA on this work.

c. Ames Research Center/Mr. M. S. Nourse, Chief of Research, Electrical Engineering Branch.
4. a. Benefits, to date, of the Ames technology, serve to prove the feasibility of telemeter transmission within the difficult environment with which Dr. Guy must contend. Further, it is established that commercial equipment (for economy) is available. A major road block has been removed; i. e., Dr. Guy can proceed knowing that he will not be stymied by feasibility or excessive cost.

b. It is difficult to predict the potential benefits. However, it is apparent that efficient telemetry will benefit patients recovering from shock, injury, or illness, because they can be instrumented and monitored when they become ambulatory. Their reactions can be compared with norms, and corrective measures can be evaluated.

- c. The original 1965 NASA study involved approximately 4 man-months' time. Assuming efficiency has increased significantly in the interim, a study without NASA assistance may have required 2 man-months' study.

Multistress Effects on the Cardiovascular System

1. a. Singly imposed stress and its resultant effects on the heart and cardiovascular system have been studied. But what happens when two or more stress elements are simultaneously applied? And what is the separate result as well as the combined result? The experimentalists had at their disposal complete inclined-plane treadmills to provide the physical-effort stress and to affect oxygen transport. It was desired to add, under controlled conditions, stress from heat and heat transfer.

b. University of Washington/Drs. Loring Rowell, John Murray.
2. Actual Transfer: Conferences with the experimentalists indicated that the desire was one of having a lightweight, flexible, and heated suit to control skin temperature and thereby control the skin's blood flow and the skin's heat transfer for the subject (so as not to interfere with physical movement); thus, one could achieve the desired experimental goals. The fact that the "Space Underwear" used by NASA Astronauts, in this case, can be heated rather than cooled came to mind. Arrangements were made by telephone with NASA-MSC for the loan of the actual suits. The experiments have been completed, the report is being written, and an abstract has been sent to MSC for their critique.
3. a. What was needed in this problem was "hardware." Since a great deal of NASA effort had been expended in the development of the astronaut's apparel, and since such actually existed, it seemed to be correct to go directly from problem to equipment without a search or a development phase.

b. Problem-solution identification was effected by knowledge of the problem from the experimentalists and from knowledge of the Manned Spacecraft Center program.

c. Manned Spacecraft Center/Mr. Paul Purser.
4. a. Actual benefits to date are that the research program has been expeditiously completed. Experimental design of step changes in skin temperature was achieved. Reports will be available during the current year.

b. Potential benefits are far reaching. Not only has a far better understanding been obtained of the mechanisms involved, but it may be possible to predict (and guard against) results on humans

exposed to a hot environment. Most satisfying is the knowledge that NASA may be able to use the results produced. This is a good example of a two-way street; i.e., NASA technology helps the biomedical community with a dividend return to NASA.

c. Savings to experimenters:

- (1) Approximately 1 year's time
- (2) Avoidance of repeated catheterization of normal subjects
- (3) Avoidance of extensive modification of existing equipment.

III. C

POTENTIAL TRANSFER

Title: Pressure Measurement to Aid Prevention
of New Decubitus Ulcers

Source: Donald R. McNeal, PhD.
Principal Engineer
Rancho Los Amigos Hospital

Date Submitted: 26 April 1968

A technique is urgently needed for measuring the distribution of pressure on the surface of the skin underlying a cast, brace, or prosthetic device, such as an artificial leg. This information would be an invaluable aid in the design of these devices because it is critical to distribute the load as evenly as possible to avoid high-pressure points which will damage the skin. At the present time, there is virtually no quantitative information of this sort available. The reason is that a satisfactory and economical technique for measuring pressure is not available.

Initial Disposition:

Since it was known that this problem area was of interest to the participating member institution, a carefully screened search yield of searches previously conducted on pressure transducer technology was sent before official problem submission to the institutional coordinator (Dr. Mooney) on 22 April 1968. In addition, the West Coast Consultant has begun an investigation of technology developed at Ames Research Center and other NASA generated technology with which the Consultant is personally familiar. He is also investigating commercial sequential pressure scanners.

Synopsis of Solution:

The problem of measuring, economically, many pressures (literally, numbered in the hundreds) involved herein is akin to the problem of measuring local pressures about a wind-tunnel model under stress. Consequently, conferences, at which a dozen potential solutions (proprietary to NASA) were discussed and considered, were held with both dynamicists and instrumentation experts at the Ames Research Center. To solve the problem rapidly, the decision was to use existing techniques; to keep the solution economical, the decision was to try to use Ames' recommended commercial products. In brief, the patient will sit upon a quilted pad, each "quilt" being a miniaturized air cushion and each connected by a miniature (0.040 in. dia) tube to a pressure cell. However, for economy, a commercial product (Scanivalve) using but one (expensive) pressure cell and a pressure "commutator" for cyclically sampling the many pressures will be employed. Construction of the quilted pad will be done by Rancho Los Amigos. The instrumentation required will be loaned (without cost) by the manufacturer who has become most interested in the humanitarian aspects.

Method by Which Identified:

Utilization of the West Coast Consultant's knowledge of this problem and of similar problems experienced by NASA.

NASA Source:

Ames Research Center/Messrs. George Edwards, TUO, who is also an authority on subsonic aerodynamics, and John Dimeff.

Benefits Derived:

For the first time, Rancho Los Amigos Hospital will have a fully instrumented approach to a problem which has existed for a very long time.

Potential benefits are significant. The Medical Director states that the County of Los Angeles sees 200 such cases each year, and that the cost of ulcer correction is about \$15,000 per case. This for just one county of one state, albeit a very large county. The humanitarian and economical potential gain is impressive.

Estimated savings to the investigator are 2 man-years of time. A second phase will most probably deal with a sophisticated approach to seat materials and design.

IV.
BIOMEDICAL PROBLEMS

IV. A

PROBLEM STATUS SUMMARIES

TEXAS INSTITUTE FOR REHABILITATION AND RESEARCH

<u>No.</u>	<u>Title</u>	<u>Status</u>
HUV-1	Reduced Workload Environment for Physically Handicapped Patients	Phase 1 and Phase 2, actual transfer; facility being evaluated by Problem Originator.
HUV-2	Advanced Computer Display and Interface Technology	Actual transfer; inactive.
HUV-3	Computer Scheduling Techniques	Actual transfer; inactive.
HUV-4	Heart Sounds, Interval Analysis	Inactive.
HUV-5	End Tidal Air Sampler	Actual transfer; inactive.
HUV-6	Ambulation Aid	Problem Abstract disseminated; inactive
HUV-7	Scheduling for Ward Patients	Actual transfer; inactive.
HUV-8	Mechanisms of Onset of Orthostatic Hypotension	Transfer completed; inactive.
HUV-9	Prosthetic Materials for Urinary Tract	Inactive.
HUV-10	Instrumented Prosthetic Leg	Microsphere cushion prototype furnished for evaluation by researchers; possible Problem Abstract.
HUV-11	Improved Gas Sample Flow Control and Measurement	Inactive.
HUV-12	Special Automobile Modifications for Disabled Persons	Inactive.
HUV-13	Human Transfer Function Measurements	Actual transfer; inactive.

TEXAS INSTITUTE FOR REHABILITATION AND RESEARCH (Cont'd)

<u>No.</u>	<u>Title</u>	<u>Status</u>
HUV-14	Physical Space Utilization	Actual transfer; inactive.
HUV-15	Advanced Computer Terminal and Display Technology	Inactive.
HUV-16	Novel Joint Design Applied to Assistive Devices for Human Limbs	Possible Problem Abstract.
HUV-17	Automatic Remote Human Movement Analysis	New Problem.
HUV-18	Microanalysis of Mucous-Secreting Cells	New Problem.

THE UNIVERSITY OF TEXAS MEDICAL BRANCH, GALVESTON

No.	Title	Status
GLM-1	Analysis of Transitional Flow-- Convection/Diffusion	Transfer accom- plished; problem closed out.
GLM-2	Monitoring of Blood Pressure by Extravascular Sensor Using Wireless Telemetry of Information	Inactive.
GLM-3	Determination of Local Blood Flow, Blood Gas Concentration, and Blood pH in Small Portion of an Organ	Actual transfer; possible Problem Abstract.
GLM-4	Implanted Blood Pressure Transducer	Actual transfer; technology being evaluated by Problem Originator.
GLM-5	Chronic Intracranial Pressure Measurement in Man	Actual transfer; technology being evaluated by Problem Originator.
GLM-6	A Model Vascular System	Actual transfer; reference documents are being evaluated.
GLM-7	Viscosity Measurement of Minute Samples of Blood	Reference documents evaluated.
GLM-8	Computer Program for Electroencephalograph: Period Analysis	Actual transfer; reference documents are being evaluated.
GLM-9	Measurement of Local Tissue Oxygen Consumption, <u>In Vivo</u>	Actual transfer; possible Problem Abstract.
GLM-10	Computer Program for Flame Spectrophotometry	Actual transfer; technology being evaluated by Problem Originator.

THE UNIVERSITY OF TEXAS MEDICAL BRANCH, GALVESTON (Cont'd)

No.	Title	Status
GLM-11	Elimination of Electrostatic Charge in Experimental Animals	Closed out; actual transfer.
GLM-12	Computer Selection and Elimination of Artifacts	Actual transfer; reference documents are being evaluated.
GLM-13	Multiple Cospectral Density Analysis of Time-Series Data	Problem Abstract disseminated; actual transfer being evaluated.
GLM-14	Repetitive Measurement of Kidney Mass in Intact Animal	References being evaluated by Problem Originator (No change).
GLM-15	Respiration Volume and Rate Measurements in Unencumbered (Free) Child	Actual transfer; Problem Originator evaluating reference material; NASA--ERC sensor prototype being furnished for evaluation; possible Problem Abstract.
GLM-16	<u>In-Situ</u> Tumor Mass Determination on Rat Leg	Technology being evaluated by Problem Originator; possible Problem Abstract.
GLM-17	Respiratory Gases Measurement	Actual Transfer; references being evaluated by Problem Originator.
GLM-18	Ultramicro Methods for Analyzing Biological Specimens	Search completed; technology being evaluated (New Problem).
GLM-19	Measurement of the Velocity of Myocardial Contractions by Noninvasive Means	New Problem.

VETERANS ADMINISTRATION SOUTHERN
RESEARCH SUPPORT CENTER

<u>No.</u>	<u>Title</u>	<u>Status</u>
SRS-1	Indirect Measurement of Blood Pressure During Rest and Exercise on Arms and Legs	Actual transfer; periodic literature review is requested.
SRS-2	Catheter-Tip Transducer for Blood Pressure and Flow Measurement	Actual transfer; periodic literature review is requested.
SRS-3	Locating Tip of Stomach Tube	Actual transfer; possible Problem Abstract.
SRS-4	Materials Suitable for Dry Electrode Fabrication	Actual transfer; inactive.
SRS-5	Temperature Regulatory Mechanisms of the Body	Inactive.
SRS-6	Investigations of Cutaneous Stimuli	Actual transfer; closed out.
SRS-7	Acoustic Pest Control Technology	Inactive.
SRS-8A	Acquisition and Telemetry of Heart Rate, Blood Pressure and Blood Flow in Free-Ranging Dogs	Actual transfer; technology being evaluated by Problem Originator (New Problem).
SRS-8B	Methods of Signal Categorization	Computer search is in progress (New Problem).

THE UNIVERSITY OF TEXAS MEDICAL SCHOOL
AT SAN ANTONIO

<u>No.</u>	<u>Title</u>	<u>Status</u>
SNM-1	Enhancement of X-Ray Contrast Study Films	Actual transfer; technology being evaluated by Problem Originator.

RANCHO LOS AMIGOS HOSPITAL

No.	Title	Status
RNV-1	Efficient Electromagnetic Power Transmission Through Living Tissue	Inactive.
RNV-2	Design of Implanted Antennas	Inactive.
RNV-3	Electrode Wires for Implantation	Inactive.
RNV-4	Optimum Neurologic Electrodes	Inactive.
RNV-5	Pressure Measurement to Aid Prevention of New Decubitus Ulcers	Potential transfer.
RNV-6	Integral Impedance Matching, Impedance Transformation, and Signal Conditioning at the Transducer	Inactive.
RNV-7	Shielded Rooms for Physiological Studies	Closed.
RNV-8	State-of-the-Art Survey of Surface Biopotential Electrode Technology (EMG, EEG, ECG, . . .)	Inactive.
RNV-9	Shielding Techniques for Active Surface Biopotential Electrodes	Closed.
RNV-10	Sensors for Measuring Foot-Floor Impact Forces	Transfer.
RNV-11	Measurement and Telemetry of Kinesiology of Handicapped Patients	Transfer.
RNV-12	Body Temperature Regulation in Congenital Amputees	Transfer.
RNV-13	Improved Laryngoscope for Use in Disabled Children	Problem Originator following up references to commercial developments.

RANCHO LOS AMIGOS HOSPITAL (Cont'd)

<u>No.</u>	<u>Title</u>	<u>Status</u>
RNV-14	Materials for Prevention of New Decubitus Ulcers	Computer search is in progress.
RNV-15	Rapid Multiple Gas Measurement for Medicine	Problem Originator evaluating commercial developments; Search Statement (citation search) preparation is in progress.
RNV-16	Patient Breathing Monitor	Transfer (New Problem).

STANFORD UNIVERSITY MEDICAL SCHOOL

No.	Title	Status
SFM-1	Automatic EKG-Time Interval Measurement	References being screened by Team.
SFM-2	Automatic Techniques for Smoothing Blood Pressure Waveforms	References being screened by Team.
SFM-3	Improved Monitoring of Heart Cell Contraction Parameters	Problem Originator evaluating search results.
SFM-4	Early Detection of Vestibular Unbalance in Children	Transfer (New Problem).

PALO ALTO MEDICAL RESEARCH FOUNDATION

<u>No.</u>	<u>Title</u>	<u>Status</u>
PLR-1	Measurement of Outer- and Inner-Diameter of Blood Vessels	Search results are being screened.
PLR-2	Measurement of Surface Kinematics of Canine Heart	Closed out.
PLR-3	Automatic Control of Therapeutic Agents	Problem Originator screening search results.
PLR-4	Exercise Tests for Detection of Heart Disease	Search Statement is in preparation (New Problem).

UNIVERSITY OF WASHINGTON MEDICAL SCHOOL

<u>No.</u>	<u>Title</u>	<u>Status</u>
WSM-1	Ultrasonic Coupling Techniques	Problem Abstract draft being planned.
WSM-2	Atherosclerotic Lesion Detection	Closed,
WSM-3	Infrared Irradiation of Skin Surface	Closed.
WSM-4A	Simultaneous Multistress Effects on the Cardiovascular System	Transfer.
WSM-5	Techniques for Restricting Blood Flow in the Legs	Inactive.

NORTHWEST HANDICAPPED CENTER

<u>No.</u>	<u>Title</u>	<u>Status</u>
NWR-1	Motion Pattern Measurement of Patients	Problem Originator studying selected documents.
NWR-2	Pressure Measurement to Aid Prevention of New Decubitus Ulcers	Closed.
NWR-3	Parameters for Telemetry Systems	Closed Transfer.
NWR-4	Exercise Device for Handicapped or Confined Patients	Closed Transfer.
NWR-5	Numerical Methods for Solutions to Wave Equations in Layered Media of Arbitrary Cross Section	Problem Abstract draft is in preparation.
NWR-6	The Effects of Electromagnetic and Acoustic Fields on Living Organisms	Search being processed at WESRAC (New Problem).

IV. B

NEW PROBLEMS

Automatic Remote Human Movement Analysis

Source: R. E. Herron, PhD
Associate Professor
Baylor University College of Medicine
Texas Institute for Rehabilitation and Research

Date Submitted: 29 October 1968

Analysis of gait patterns may prove to be of great value in determining proper application and fit of orthotic and prosthetic devices. Means for measuring and analyzing human motion are sought.

Initial Disposition:

Before choosing an approach to this problem, prior search results (NWR-1), Tech Brief 67-10114, "Integrated Mobility Measurement and Notation System," with backup package and other applicable references, were sent to the Problem Originator by Mr. Berger, 30 October 1968.

Communications:

22 November 1968--Dr. Herron reported that the results were good, but that he would like to receive information on the technology, developed by SwRI, which may be applicable to this problem.

Microanalysis of Mucous-Secreting Cells

Source: Mr. Robert G. Doggett
Director of Cystic Fibrosis Research Laboratory
Baylor University College of Medicine
Texas Institute for Rehabilitation and Research

Date Submitted: 30 October 1968

The Problem Originator wishes to find a technique for analyzing the chemical constituents of microscopic portions of a mucous-secreting cell specimen from a cystic fibrosis patient. The secretions of patients with cystic fibrosis are known to be abnormally high in sodium, which forms the basis for a screening test to detect the disease in its early stages. Analyzing and localizing the metabolic derangement, and correlating these with the secretory cells may lead to advances in cystic fibrosis research.

Initial Disposition:

Possible applicability of the search results from GLM-18, "Ultra-micro Methods for Analyzing Biological Specimens."

Communications:

4 November 1968--In further discussion, Mr. Doggett told Mr. Crosby that he was most interested in having arrangements made to use the electron probe analyzer at the Manned Spacecraft Center in Houston so that the feasibility of this approach may be determined.

4 November 1968--Dr. Ware telephoned Mr. Copeland of Manned Spacecraft Center, Houston. Mr. Copeland promised to make official arrangements for Mr. Doggett to use the NASA facilities.

Ultramicro Methods for Analyzing Biological Specimens

Source: C. Ward Kischer, PhD
Assistant Professor
Department of Anatomy
University of Texas Medical Branch
Galveston, Texas

Date Submitted: 10 October 1968

The Problem Originator wishes to find a technique for identifying and analyzing the hormones or other chemical agents which control the differentiation and development of chick embryo cells from skin into feathers. Ordinary methods of chemical analysis are not applicable because of the extremely small quantity, high dilution, and localization of the active chemicals within individual cells.

Initial Disposition:

Computer Search of NASA Data Bank.

This problem was discussed with Mr. W. L. Rollwitz, Manager of the Electronics Instrumentation Section, SwRI, concerning the applicability of nuclear magnetic resonance and X-ray fluorescence techniques to this problem. The applicability of chromatographic techniques was discussed with Mr. John Rhoades of the SwRI Chemistry Department, and activation analysis and other techniques with Dr. J. N. Bollinger who is a biochemical specialist at SwRI.

Communications:

30 October 1968--Mr. Crosby submitted a document search statement to WESRAC.

29 November 1968--The WESRAC search results were screened prior to forwarding to Problem Originator.

Measurement of the Velocity of Myocardial Contraction by
Noninvasive Means

Source: Quang X. Nghiem, MD
Assistant Professor, Department of Pediatrics
Assistant Director, Pediatric Cardiology
The University of Texas Medical Branch
Galveston, Texas

Date Submitted: 10 October 1968

Cardiologists need to assess the condition of the heart without introducing contrast media or without performing surgery. It is believed that velocity of motion of the heart wall is an index of contractility. The goal of the researcher is to investigate noninvasive techniques for measurement of heart wall motion. The use of ultrasonic Doppler has been suggested.

Initial Disposition:

Computer Search of NASA Data Bank.

Communications:

31 October 1968--Search statement was sent to WESRAC.

11 November 1968--Mr. Laenger sent copies of appropriate technical documents on uses of ultrasonic Doppler to Dr. Quang Nghiem.

14 November 1968--Mr. Bruno Iachia of WESRAC called to recommend addition of certain key words to the search statement. Mr. Laenger confirmed that our interest was in heart wall motion.

Acquisition and Telemetry of Heart Rate, Blood Pressure, and Blood
Flow in Free-Ranging Dogs

Source: Joseph E. O. Newton, MD
Research Physiologist, VA Hospital, NLR Division
North Little Rock, Arkansas

Date Submitted: 21 October 1968

Correlation of physiological parameters with psychological disorders is the ultimate goal of this investigation. If such correlation is achieved, better psychiatric diagnostic and therapeutic methods may be developed. This could result in contributions to the care and cure of thousands who are confined in this country each year for the treatment of mental disease. A breakthrough in this area could result in reclamation of many useful lives.

The researchers engaged in this work are psychologists and neuro-physiologists. They are presently acquiring blood pressure and heart rate data by direct means from carefully developed strains of normal and "nervous" dogs. The instrumented dog is permitted to move about in a 10-foot-square enclosure. Connections to cardiovascular data-acquiring systems are made to the animal via plastic tubing housed in a protective cable. It is felt that more valid data could be acquired if the animal were permitted to move about within a considerably larger area without encumbering wires or tubes. The problem is to identify a suitable and economical means for obtaining heart rate, blood pressure, and blood flow data, and for transferring this information to a remote location via wireless telemetry.

Initial Disposition:

Problem received and reviewed by Biomedical Application Team members and subsequently assigned to Mr. C. J. Laenger.

Communications:

24 October 1968--The problem was discussed with Jack Johnson. It was agreed that the ECG waveform question should be handled separately. (Designated SRS-8B). Mr. Johnson agreed that the T/M articles plus the information on commercial instrumentation (he ordered literature from the sources previously supplied by the Biomedical Application Team) would be sufficient at the present time, and that a new search would not be necessary or appropriate.

28 October 1968--The NASA-Ames telemetry package was requested from Mr. A. G. Buck. Mr. Berger wrote description of ECG portion of problem (SRS-8B).

31 October 1968--Mr. Laenger wrote a letter to Mr. Jack Johnson explaining status of the problem. Mr. Laenger requested comments on statements of the problems which were included.

11 November 1968--Screened search (updating) results received from KASCenter on 25 October.

11 November 1968--Received ten documents and forwarded them to Southern Research Support Center.

12 November 1968--Sent screened results of biotelemetry search updating.

26 November 1968--Dr. Joe Newton and Mr. Jack Johnson, Southern Research Support Center, visited Mr. C. J. Laenger. Telemetry problems and the use of ultrasonic transducers vs electromagnetic transducers were discussed.

2 December 1968--A letter was received from Dr. Newton stating that he has made a decision to use ultrasonic Doppler for measuring and telemetering blood flow velocity information.

Methods of Signal Categorization

Source: Joseph E. O. Newton, MD
Research Physiologist, VA Hospital, NLR Division
North Little Rock, Arkansas

Date Submitted: 21 October 1968

In the research described in Problem SRS-8A, electrocardiograms from two strains of dogs are being obtained. Broadly speaking, there appear to be differences in the signals of the two categories which are perceived by human observer. The technique sought is one that is suitable for quantifying this subjectively observed difference.

There are several standard techniques for quantifying and comparing time series signals. However, the most common of these (spectral analysis, auto- and cross-correlation) may not uncover the desired quantitative information. It is hoped that what will be uncovered are new concepts of signal categorization which are applicable to the above problem.

Initial Disposition:

Computer Search of NASA Data Bank.

Communications:

29 October 1968--Search Statement draft prepared by L. Berger; forwarded to WESRAC.

31 October 1968--Wrote letter to Mr. Jack Johnson explaining status of the problem. Requested comments on statements of the problem which were included.

14 November 1968--Mr. L. Berger discussed search preparation during his visit at WESRAC with Mr. Tolivar. Preparation of search strategy was initiated.

Patient Breathing Monitor

Source: Claire Stiles, MD
Chief Anesthesiologist
Department of Pediatrics
Rancho Los Amigos Hospital

Date Submitted: 3 October 1968

Tracheotomies, requiring insertion of breathing tubes, seem to be very common, and are particularly frequent surgeries in infants and in children. In each case, and most especially so in the case of children, an unremitting vigil must be maintained to be certain that the breathing tube will never become mucous-clogged, preventing a catastrophic result.

Initial Disposition:

Direct communication with NASA-Ames.

Communications:

7, 8, 11 October 1968--Mr. Buck, in response to discussions with Dr. Stiles, visited NASA-Ames. He picked up a preliminary descriptive package (ARC-10174) and forwarded it to Dr. Stiles on 11 October.

11 October 1968--In response to Dr. Stiles' letter of October 3, Mr. Buck provided preliminary information on the NASA-Ames "Patient Breathing Monitor." This information was furnished through the courtesy of Mr. George Edwards (Technology Utilization Officer), Mr. John Dimeff (Chief Instrumentation Division), Mr. Howard Kirschbaum (Executive Engineer, Instrumentation Division), all of Ames Research Center.

28 October 1968--NASA, Ames Research Center Tech Brief 68-10365, "Automatic Patient Respiration Failure Detection with Wireless Transmission," became available and was sent to Problem Originator.

2 November 1968--A backup package to the Ames Research Center Tech Brief was forwarded to the Problem Originator.

25 November 1968--Mr. Buck visited Dr. Stiles; arrangements to make a unit in-house have been completed. A Technology Transfer has been accomplished.

Early Detection of Vestibular Unbalance in Children

Source: Reuven Kohen-Raz, PhD
Department of Pediatrics
Stanford School of Medicine

Date Submitted: 17 October 1968

It is believed that early detection of vestibular, or other, unbalance in children can lead to corrective treatment. Failure to recognize this condition, which is frequently evident only upon precise measurement, can lead to a situation when corrective effort is no longer effective; it is too late.

Precise measurement of toe and heel pressures of each foot, the feet being first in parallel, then heel-to-toe, both statically and dynamically, is required. Second, since we are dealing with children, an inducement or "reward" is necessary so that they will do their best to maintain balance.

Initial Disposition:

Direct contact with NASA-Ames.

Communications:

28 October 1968--Consultant relayed to Problem Originator results of meeting with Mr. John Dimeff, Chief of the Instrumentation Division, Ames Research Center and with Messrs. Rositano and Kolbe. Their advice included design concepts and reference to a source of possible engineering support.

5 November 1968--Conference with investigator. NASA-Ames' recommendations accepted regarding Phase I (accurate toe and heel plates for each foot, wire-strain-gauge-force balance, from wind tunnel technology). Contract with Straindyne Company for manufacture.

6 November 1968--Phase II ("Reward"). Visit Ames and borrow, for demonstration, synch-motor-switch, two-channel, and suitable audio equipment. The above recommended by Mr. Harry J. DeVoto, Chief of Graphics and Presentation Branch.

8 November 1968--Demonstrated audio-visual equipment to Problem Originator who accepted the solution and who will request an 8-month loan of such hardware from Ames.

18 November 1968--Visit Ames, on request, to clear Stanford's loan request.

28 November 1968--Manufacture of force balance equipment (Phase I) complete; calibration begun. This is to be ready for Problem Originator 6 December. Phase II loan equipment request being processed.

Actual transfer (2): Phase I (Instrumentation)--NASA-Ames, Messrs. Dimeff, Rositano, Kolbe. NASA was the pioneer in selected type of instrumentation; there are now a few commercial firms that have "caught up." Mr. McFarland, President of Straindyne, formerly of Ames, states that the majority of his applicable experience comes from Ames.

Phase II--NASA-Ames, Mr. Harry J. DeVoto, an expert in aeronautics-astronautics research presentation, provided guidance.

Exercise Tests for Detection of Heart Disease

Source: Noel P. Thompson, MD
Chief, Bioengineering and Physiology Division
Palo Alto Medical Research Foundation

Date Submitted: 25 November 1968

This problem is submitted with the hope of utilizing the comprehensive services of the NASA Computer Data Bank for an indication of direction of effort. The researcher wishes to compare bicycle and/or treadmill exercise electrocardiography with the Master's Step Test. Of primary interest are studies which compare these types of exercise tests in terms of their ability to detect those heart diseases caused by insufficient blood supply to the cardiac muscle.

Initial Disposition

Computer search of the NASA Data Bank.

Communications:

19 November 1968--A copy of a paper, "Electrocardiographic Response to Maximal Exercise," American Journal of Cardiology, No. 20, October 1967, was forwarded to researcher. This paper was furnished through the courtesy of John B. Murray, MD, School of Medicine, University of Washington, during a visit to Dr. Murray by Messrs. Buck and Berger, 13 November 1968. Dr. Murray suggests a second paper, which he does not have: American Heart Journal, Vol. 69, pp 11-21, 1965, by Doan, Peterson, and Blackmon.

25 November 1968--Dr. San Martin's comments regarding search terminology were furnished to Mr. Buck, who is preparing a search statement.

The Effects of Electromagnetic and Acoustic Fields on Living Organisms

Source: Dr. Arthur W. Guy
Assistant Professor
Northwest Institute for Rehabilitation and Research

Date Submitted: 13 November 1968

A comprehensive search was requested of studies relating to the effects of static and time-varying fields as reference backup before undertaking planning of specific research projects. This problem was submitted verbally to Mr. L. Berger during a visit to Dr. Guy's laboratory.

Initial Disposition:

It is planned to discuss the search strategy during a visit to WESRAC 14 November 1968.

Communications:

14 November 1968--During his visit to WESRAC, Mr. L. Berger explained the search requirements to Messrs. Torok and Tolivar. This problem was explained to Mr. Berger by the Problem Originator during a site visit on 13 November, and the problem was taken directly to WESRAC for search preparation. Dr. Bruno Iachia, WESRAC search specialist, called Dr. Guy to establish the relevant spectral limits (nonionizing radiation to 30 GHz, and no X-radiation or visible light spectral range).

IV. C

PROBLEM CASE HISTORIES

■ HUV-1 Reduced Workload Environment for Physically Handicapped Patients

Communications:

2 October 1968--Mr. R. J. Crosby and F. L. St. Claire, in telephone conversation with Mr. Joe Canzoneri, established that Texas Institute for Rehabilitation and Research had received various equipment from Langley Field. TIRR has produced detailed drawings and received bids for facility construction. Researchers at TIRR are also attempting to find out more about a vertical reduced gravity simulator.

8, 9 October 1968--Messrs. C. J. Laenger and R. J. Crosby visited Texas Institute for Rehabilitation and Research. They examined a Reduced Gravity Simulator model. A contractor has been employed to construct the large prototype hardware. Also, measurements of some physiological parameters (cardiac output by Kubicek's method and SwRI blood pressure ultrasonic Doppler method) are being attempted on subjects who are exercising on the reduced gravity simulator.

■ HUV-9 Prosthetic Materials for Urinary Tract

Communications:

2 December 1968--Dr. Ware sent article "Chemistry of Hydron, "
Hydron Quarterly Review, Vol, 1, No, 1, to Dr, Scott.

■ HUV-10 Instrumented Prosthetic Leg

Communications:

14 November 1968--The requirements for automatic processing of the five-channel data output were explained to Messrs. Tolivar and Torok by L. Berger during his visit to WESRAC. They were given a draft of a paper prepared by Dr. Peterson and are proceeding with search preparation. Preparation of a Problem Abstract in parallel is being considered.

20 November 1968--Forwarded to Mrs. Marks two copies each of three Armour Research Foundation Reports on prosthetic limb devices, 1946-7, describing microsphere (so-called "Dilatency Technique") cushion technology:

- (1) Development of Prosthetic Devices, Progress Report No. 1, Project 1-424-F, Armour Research Foundation, October 16, 1946.
- (2) Progress Report No. 2, ARF, January 1, 1947.
- (3) Terminal Research Reports, Committee on Artificial Limbs, National Research Council, June 30, 1947.

This information was furnished to SwRI on request of Mr. L. Berger through the courtesy of Mr. A. Bennett Wilson, Jr., of The National Research Council.

■ HUV-12 Special Automobile Modifications for Disabled Persons

Communications:

11 November 1968--In response to a suggestion by Mr. Bennett Wilson of the National Research Council, Prof. Charles Radcliff at the University of California, Berkeley, was called to obtain information about the status of research going on in the subject area. Prof. Radcliff is forwarding reports on work being sponsored by SRS. This work is a follow-up program of a master's thesis project and is being directed by Prof. Don Cunningham.

18 November 1968--Information on the University of California (Berkeley) research received from Prof. D. M. Cunningham and forwarded to Mr. Reese, together with GM developments; referred to SwRI courtesy of Mr. A. Bennett Wilson, Jr., National Research Council.

■ GLM-2 Monitoring of Blood Pressure by Extravascular Sensor
Using Wireless Telemetry of Information

Communications:

25 October 1968--Received search (updating) results from KASCenter.

12 November 1968--Sent screened results of biotelemetry search
updating to Problem Originator.

■ GLM-5 Chronic Intracranial Pressure Measurement in Man

Communications:

8 October 1968--Mr. C. J. Laenger and Mr. R. J. Crosby visited Dr. Rudenberg and Mr. Peel. Experimental work is in progress. Commercial pressure transducers have been acquired.

■ GLM-6 A Model Vascular System

Communications:

8 October 1968--Attempts by Dr. Rudenberg to obtain response from Dr. Cooley have been unsuccessful. This problem has been closed.

■ GLM-13 Multiple Cospectral Density Analysis of Time-Series Data

Communications:

8 October 1968--Dr. Rudenberg reported that this problem has been solved by the researcher. This problem has been closed.

■ GLM-15 Respiration Volume and Rate Measurements in Unencumbered (Free) Child

Communications:

23 September 1968--Mr. Berger informed Mr. Hills that we would estimate the needed evaluation time after the unit was delivered to Dr. Wilson.

1 November 1968--Mr. C. J. Laenger spoke with Mr. Fred Hills, TU Office, Cambridge. Mr. Hills promised to send the prototype respirometer with a circuit diagram of instructions.

18 November 1968--Information on commercial gas chromatography, especially suitable for respiratory analysis applications, forwarded to consultant.

■ GLM-16 In-Situ Tumor Mass Determination on Rat Leg

Communications:

5 November 1968--Robert J. Crosby scanned the WESRAC search returns of September 16, 1968. The search returns held little of interest. The only article that showed any prospect was A68-21795, "Growth Kinetics of Solid Lymphosarcome NKLy Under the Action of Various Doses of Ionizing Radiation." A Xerox copy of the search returns was sent to Dr. Rudenberg. Mr. Crosby suggested that a Problem Abstract be prepared.

14 November 1968--Mr. R. J. Crosby found reference to soft tumor detection in rats by ultrasonic holography on pages 34 and 36b of the October 1968 issue of Laser Focus magazine. He sent a Xerox copy of the article to Dr. Rudenberg.

22 November 1968--Mr. R. J. Crosby and Mr. Sam Schiflett visited Dr. Rudenberg in Galveston. Dr. Rudenberg said that he thought the method of ultrasonic holography might hold some promise and gave Mr. Crosby a copy of an abstract of a paper by Weiss and Holyoke which was referenced in the Laser Focus article.

29 November 1968--Dr. Ray W. Ware received a letter from Dr. F. Thomas Wooten at Research Triangle Institute in which he said that Dr. F. L. Thurstone of Duke University had been consulted on GLM-16. Dr. Thurstone's opinion was that ultrasonic holography was unlikely to work and that the best approach would be a compound-B scan-pulse-echo ultrasonic technique to measure the cross section of the limb at various points along its length. He also cited the paper by Weiss and Holyoke as a reference to the detection of soft tumors by ultrasonic holography.

■ GLM-17 Respiratory Gases Measurement

Communications:

18 November 1968--Information on commercial gas chromatography, especially suitable for respiratory analysis applications, forwarded to consultant.

- RNV-1 Efficient Electromagnetic Power Transmission
 Through Living Tissue

Communications:

15 November 1968--The investigator, when interviewed by Messrs. Buck and Berger, stated that the search provided about eight articles of primary interest and three articles of interest in related research. This material is most relevant to work which will be performed in a later stage of the research project. It was agreed to put this problem on the inactive list, until a stage is reached in the course of the research program where further application of the results is possible.

■ RNV-2 Design of Implanted Antennas

Communications:

17 October 1968--Problem Originator furnished Mr. Buck a breakdown of the articles that had been ordered and received as a result of the WESRAC search. Approximately one-fifth of the cited references were ordered for RNV-2. Of the 12 articles ordered from WESRAC, eight were considered pertinent to the specific problem and four pertinent to other problems.

21 October 1968--Consultant met with Messrs. Dole, Torok, Schwarz, and Dr. Iachia of WESRAC to discuss the second round of searching. A revised search strategy was used, and manual screening and comparison with previous runoff is underway.

25 October 1968--Search Supplement returned from WESRAC.

28 October 1968--NASA Tech Brief 68-10328, "Transistorized Marx Bank Pulse Circuit Provides Voltage Multiplication with Nanosecond Rise-Time," was sent to Problem Originator.

15 November 1968--Messrs. Berger and Buck interviewed the Problem Originator. A revised search had been performed on this problem, since it was felt that the primary search strategy could be improved. In the researcher's opinion, the second search results reflected the altered search strategy, showing a difference in orientation. The second search provided useful articles, including a substantial number on mathematical modeling of nerves. This type of reference had not been located in the first search, nor was it seen in previous literature scans by the Problem Originator. Furthermore, the Problem Originator's interaction with researchers at Ames, particularly with Mr. Thomas Fryer, was deemed to be very worthwhile in that it substantiated the validity of the proposed research approach and in that the conversations clarified the problem in several technical areas: miniature circuitry; and induction coupling versus RF transmission. Twelve references from the re-search were ordered and are to be studied in detail when time permits. For the present, this problem is being placed on the inactive list.

■ RNV-3 Electrode Wires for Implantation

Communications:

7 October 1968--Information on Medwire Corporation electrode wires forwarded to Consultant.

17 October 1968--Problem Originator furnished Mr. Buck a breakdown of the articles that had been ordered and received as a result of the WESRAC search. Approximately one-fifth of the cited references were ordered for RNV-3.

15 November 1968--During an interview with Messrs. Buck and Berger, the investigator stated that he had screened the search abstracts and found six articles which he ordered for further study. Of these, one was deemed to be of primary interest, while five were judged to be of interest for further research. No immediate application of the search results is possible at this time, and the problem was put on the inactive list.

20 November 1968--Material on commercial coated and microelectrode wires (Medwire Corporation), received in response to inquiry by Mr. L. Berger, was forwarded to Consultant.

■ RNV-4 Optimum Neurological Electrodes

Communications:

17 October 1968--Problem Originator furnished Mr. Buck a breakdown of the articles that had been ordered and received as a result of the WESRAC search. Approximately one-fifth of the cited references were ordered for RNV-4. Of the eight articles ordered from WESRAC, five were received to date, of which two were pertinent to the specific problem and two were deemed pertinent to other problems.

15 November 1968--During an interview with Messrs. Buck and Berger, the investigator stated that he had screened the search abstracts and found seven articles which he ordered for further study. Of these, four were deemed to be of primary interest and one was judged to be of interest for further research. No immediate application of the search results is possible at this time, and the problem was put on the inactive list.

■ RNV-5 Pressure Measurement to Aid Prevention
 of New Decubitus Ulcers

Communications:

25 October 1968--The results of his conference with Messrs. Rositano and Kolbe of the NASA-Ames Instrument Division were forwarded by Mr. Buck to the Problem Originator by way of the Institutional Consultant. Literature concerning pressure sensitive paint and pressure cells from a commercial source was made available to Problem Originator.

15 November 1968--Problem Originator was interviewed by Messrs. Berger and Buck. No new developments had occurred at that time.

25 November 1968--Liaison was established between Dr. Marvin Sachs, University of Pennsylvania, and Rancho Los Amigos on November 25. Construction details were left with Rancho Los Amigos. The philosophy of the measurements of sitting pressures is identical to that proposed previously by NASA-Ames through the Biomedical team to the Problem Originator. Individual small pressure cells are to be scanned in sequence, using the previously suggested commercial "Scanivalve." The Pennsylvania cells are thin ($6/100 \times 3/8 \times 3/8$ in.) metal cells rather than plastic pillow and will permit greater accuracy. Construction cost is greater, but not exorbitant. The Problem Originator is planning to initiate research to evaluate the proposed technology (Potential Transfer).

2 December 1968--A staff contact at SwRI, regarding pressure measurement technology utilizing microcapsules, was furnished to Consultant for Problem Originator's reference.

- RNV-6 Integral Impedance Matching, Impedance Transformation, and Signal Conditioning at the Transducer

Communications:

15 November 1968--Messrs. Berger and Buck interviewed the Problem Originators, Dr. Waring and Mr. Hobart. The search results were discussed. Thirteen articles were ordered for further study, of which 11 had arrived and have been screened. Three of these were of primary interest, two of general interest, two of little interest, and one of interest to future research. Articles on electromagnetic interference, shielding concepts, differential amplifiers, and lowpass filtering were of interest. Although the material in these articles has not directly been applied, it is expected that it will be useful during the course of the research program in the future. At present, this problem has been placed on the inactive list.

■ RNV-7 Shielded Rooms for Physiological
Studies

Communications:

15 November 1968--Messrs. Buck and Berger interviewed the researchers, Dr. Waring and Mr. Hobart. The search was of very little help. Five documents were ordered for further study, of which four were of general interest and one was directly relevant to the problem. Since the search did not discover any applicable technology, and since the principal investigators are not at this time able to pursue the problem further, it has been closed out.

- RNV-8 State-of-the-Art Survey of Surface Biopotential
Electrode Technology (EMG, EEG, ECG, ...)

Communications:

15 November 1968--Messrs. Buck and Berger interviewed the Problem Originators, Dr. Waring and Mr. Hobart. The results of a WESRAC search were discussed. Thirteen of the abstract citations were ordered in full document form for further study. Of the references received so far, four are of relevance to the problem, three are of general interest, and one is of little interest. The search is judged to be of value as background material. It substantiated that there were no important areas of surface biopotential electrode technology which were not familiar to the researchers. It would be desirable to update this search in approximately 6 months. This problem was put on the inactive list.

■ RNV-9 Shielding Techniques for Active
Surface Biopotential Electrodes

Communications:

15 November 1968--Messrs. Buck and Berger interviewed the investigators, Dr. Waring and Mr. Hobart. They stated that the WESRAC search had been of limited help in that the articles of interest were not applicable at this time. These might very well be useful when the research program had progressed to a later stage. The problem was accordingly closed out.

■ RNV-10 Sensors for Measuring Foot-Floor
 Impact Forces

Communications:

1 October 1968--Problem statement and method of measurement (proposed by Dr. Perry) was sent to Dr. U. S. Lindholm, Manager, Solid Mechanics, Department of Mechanical Sciences, SwRI, for review and recommendations.

10 October 1968--Comments and suggestions on proposed research design were prepared by Drs. Lindholm and L. M. Yeakley of the Department of Mechanical Sciences at SwRI. This information was forwarded to Problem Originators for their study.

25 October 1968--The results of his conference with Messrs. Rositano and Kolbe of the NASA-Ames Instrument Division were forwarded by Mr. Buck to the Problem Originator by way of the Key Consultant. Literature concerning pressure sensitive paint and pressure cells from a commercial source was made available to Problem Originator.

15 November 1968--Messrs. Berger and Buck interviewed Mr. Antonelli. The miniature pressure transducer technology (TB 68-10246) which was made available for evaluation to Mr. Antonelli by North American Rockwell was discussed. These units were judged to provide an excellent standard having outstanding stability and linearity. They will be used for calibrating other pressure transducers and will thus perform an important function. It is considered that this constitutes a transfer in progress. Since these cells are not commercially available, Mr. Antonelli therefore requested that a literature search be performed on his problem. He will collaborate with Mr. Buck in defining the Search Statement.

25 November 1968--Actual presentation of two specially constructed radial-lead cells to the Rancho Los Amigos Hospital (D. Antonelli receiving on behalf of Dr. V. Mooney); actual transfer of NASA-NAR technology and working hardware.

■ RNV-11 Measurement and Telemetry of Kinesiology
 of Handicapped Patients

Communications:

15 November 1968--Messrs. Berger and Buck interviewed Mr. Antonelli. As a result of the advice of Mr. Buck and researchers at NASA-Ames, Mr. Antonelli had been in touch with the Whittaker Company and was provided with a great deal of technical information which he had been unable to obtain previously, although it was actively sought. There is a possibility of obtaining equipment for evaluation at some time in the future.

18 November 1968--Updated search arrived from KASC. Mr. C. J. Laenger, Sr., is screening the search yield.

19 November 1968--Screened and forwarded through A. G. Buck three previous KASCcenter telemetry searches.

19 November 1968--Sent screened results of biotelemetry search updating.

25 November 1968--KASC search delivered, Transfer data read, added to, approved by D. Antonelli (new search request data also received from Mr. Antonelli). Technology transfer involved is actual hardware of NASA-NAR origin. It will be used as both a prototype and a standard. As a prototype, it is useful as is. It will also provide a basis for grant application.

■ RNV-12 Body Temperature Regulation in
Congenital Amputees

Communications:

15 October 1968--The results of his discussion with Mr. James Silver, Assistant Chief of the Research Facilities Engineering Branch, NASA-Ames Research Center, regarding the temperature control problem, were forwarded by Mr. Buck to the Problem Originator. Specific suggestions about commercially available temperature control valves were made.

25 October 1968--Mr. A. G. Buck furnished Problem Originator the results of the above discussion. Detailed suggestions regarding commercially available products were presented to the Problem Originator,

15 November 1968--Dr. Garrett was interviewed by Messrs. Berger and Buck. The requested loan of the space garments (from NASA/MSC) has been made, and these garments will be used when the research program is implemented.

25 November 1968--Arrangements have been completed to begin research when suitable patients become available. Transfer of loan hardware is complete.

■ RNV-13 Improved Laryngoscope for Use
 in Disabled Children

Communications:

11 October 1968--Mr. A. G. Buck sent search statement drafts to SwRI for review. Mr. Berger made minor suggestions and returned the drafts to Mr. Buck for processing at WESRAC.

15 October 1968--Search statement draft forwarded to WESRAC.

17 October 1968--Consultant relayed to Problem Originator letters from the Nikon Company and from the Bendix Corporation. The commercial replies were negative but suggested some possible alternative commercial sources.

21 October 1968--At a meeting with Messrs. Dole, Torok, Schwarz, and Dr. Iachia of WESRAC, search strategy was discussed and finalized.

31 October 1968--The Problem Originator acknowledged receipt of the information furnished by Mr. Buck, 17 October 1968, and stated that she was following up the lead of possible commercial sources of a fiber optic laryngoscope.

2 November 1968--WESRAC document search returned to Problem Originator.

15 November 1968--Dr. Stiles was interviewed by Messrs. Berger and Buck. Dr. Stiles has reviewed the search and has found two articles of potential interest (A67-25881 describes a commercial device which may be adaptable to her needs, and N68-17041 is a translation of a Russian report which according to the abstract makes mention of suitable manufactured devices). These two articles will be ordered for study. It is also planned to prepare a Problem Abstract for dissemination.

18 November 1968--"Sophisticated Light Management Using Developments in Fiber Optics," P. Fyfe, Optical Spectra, July-August, 1968, sent to Consultant (contains reference to IIT Res. Inst. laryngoscope development).

■ RNV-14 Materials for Prevention of New Decubitus Ulcers

Note:

Although this problem has been described in the "New Problem" Section of the previous Quarterly Progress Report (15 October 1968), no Initial Disposition had been made at that time.

Initial Disposition:

8 October 1968--Following a telephone consultation with Mr. Buck, it was agreed to write a Search Statement for this problem at SwRI. Dr. Thein Wah will serve as ad hoc team member and provide expert guidance in describing this problem.

Communications:

9 October 1968--The submitted problem was discussed with two members of the Department of Structural Research at SwRI (Dr. Thein Wah, Staff Scientist; and Dr. Lee Calcote, Senior Research Engineer) as background to their preparation of a search description statement for submission to WESRAC. This statement will present the medically desirable properties of the material in engineering mechanics terminology.

28 October 1968--Dr. Wah and Mr. Berger called the Problem Originator. The constraints on the problem solution were clarified; difficulties with previous solutions were elucidated; in particular, the problem of lateral instability was discussed at some length. The possibility was raised by Dr. Wah that this problem is more of a design problem than a materials problem, but it was decided that a search for materials would nevertheless be conducted. Dr. Wah will prepare the appropriate search description based on the additional understanding of the problem derived from the telephone conversations with Dr. Stauffer.

29 October 1968--Search statement draft prepared by Dr. T. Wah forwarded to WESRAC.

2 November 1968--Supplementary information furnished to WESRAC by West Coast Consultant.

14 November 1968--L. Berger discussed search preparation during his visit at WESRAC with Mr. Tolivar. Preparation of search strategy was initiated.

15 November 1968--Problem Originator was informed that a computer search of his problem is in progress.

■ RNV-15 Rapid Multiple Gas Measurement for Medicine

Communications:

7 October 1968--Information on Finnigan 1015 Laboratory Mass Spectrometer forwarded to Consultant.

14 October 1968--Detailed information, including purchase and rental costs, concerning the mass spectrometer was provided to the Problem Originator. Mr. Buck visited Finnigan Electronics to follow up on SwRI lead. He forwarded results of the conversation to Dr. Hackney. Follow-up arrangements were made with Finnigan at that time,

7 November 1968--Problem Originator received commercial information from Finnigan Instrument Company.

11 November 1968--The West Coast Consultant was furnished a reference from the Excerpta Medica, Section 27, Vol. 2, No. 10, October 1968, on a report in the Journal of Scientific Instruments, titled "An Inexpensive Breakable Quadrupole Mass Spectrometer," Smith and Cromey, Journal of Scientific Instruments, 1968, 2/5 (523-527).

15 November 1968--Messrs. Buck and Berger interviewed the Problem Originator. Since the commercially available technology has not answered his needs, it was decided to perform a search on this problem. The Problem Originator is interested in wide search coverage. It was therefore decided to perform a citation search on this problem.

18 November 1968--Information on commercial gas chromatography, especially suitable for respiratory analysis applications, forwarded to Consultant.

■ SFM-1 Automatic EKG-Time Interval Measurement

Communications:

13 October 1968--Material on various commercial data processing equipment and references (University of Arizona paper on Analog/Hybrid Software, ACL-150 and NASA Tech Brief 68-10296) were furnished by Mr. John C. Dusterberry, Asst. Division Chief, Simulation Sciences Division, NASA, Ames Research Center.

2 December 1968--Selected references were forwarded to Mr. Buck for screening.

■ SFM-3 Improved Monitoring of Heart Cell Contraction Parameters

Communications:

11 October 1968--Mr. A. G. Buck sent search statement drafts to SwRI for review. Mr. L. S. Berger made minor suggestions and returned the drafts to Mr. Buck for processing at WESRAC.

15 October 1968--Search statement draft forwarded to WESRAC.

21 October 1968--At a meeting with Messrs. Dole, Torok, Schwarz, and Dr. Iachia, WESRAC, search strategy was discussed and finalized.

10 November 1968--WESRAC Search No. 47-300, returned to Problem Originator with consultant's cover letter giving an initial evaluation of the search yield.

■ PLR-1 Measurement of Outer- and Inner-Diameter of Blood Vessels

Communications:

11 October 1968--Mr. A. G. Buck sent search statement drafts to SwRI for review. Mr. L. S. Berger made minor suggestions and returned the drafts to Mr. Buck for processing at WESRAC.

15 October 1968--Search statement draft forwarded to WESRAC.

21 October 1968--At a meeting with Messrs. Dole, Torok, Schwarz, and Dr. Iachia of WESRAC, search strategy was discussed and finalized.

7 November 1968--Consultant stated that the Problem Originator was reviewing the search results. These had been returned to him on November 4.

■ PLR-2 Measurement of Surface Kinematics of Canine Heart

Communications:

8 October 1968--In conversation with Mr. Buck, it was established that Problem Originator had found, on his own, a satisfactory approach to this problem. Should additional questions arise during his experimental investigation, the researcher will pose new derivative problems at such time. This problem is terminated.

14 October 1968--"A New Device for Recording Cardiac Motion," Medical Engineering, 3rd Quarter, 1968, sent to Mr. Buck for relay to the Problem Originator as a backup for the "Heart Motion Video Tracker" furnished earlier.

■ PLR-3 Automatic Control of Therapeutic Agents

Communications;

7 November 1968--Problem Originator was interviewed. He stated that he had been able to go through about one-half of the search yield, and that so far the search abstracts had not been of any significant use to him.

■ WSM-1 Ultrasonic Coupling Techniques

Communications:

10 October 1968--Mr. Buck requested a Problem Status Evaluation from the Problem Originator.

12 November 1968--Problem Originator was interviewed by Messrs. Buck and Berger. The primary and supplementary search results were of no direct help in answering the submitted questions, but several references (N65-28704, A64-22956, A64-25715) were of potential interest to other problems. While these references have not been of any direct value to date, any future applications will be documented by the Problem Originators. It was agreed that this problem would have a Problem Abstract draft prepared; Mr. Baker, Mr. Buck, and Mr. Laenger cooperating to prepare the draft.

■ WSM-2 Atherosclerotic Lesion Detection

Communications:

2 October 1968--Two references cited by Mr. Charles Hermarch, Chief of the Materials Research Branch, Ames Research Center, NASA, were forwarded to Problem Originator: "Time-Temperature Strain Rate Equivalence for Various Engineering Thermoplastics," by Lohr, et al., and "Accelerated Testing of the Mechanical and Thermal Integrity of Polymeric Materials" by Lohr, et al. The consultant also provided the Problem Originator with suggestions for three commercial sources of testing machines.

12 November 1968--Messrs. Buck and Berger interviewed the Problem Originator. One search reference proved to be of significance: N65-29149, titled "A Theory for the Static Elastic Behavior of Blood Vessels," Picker and Sacks (Palo Alto Med. Res. Found.), Pergamon Press, 1967. This reference lent support for the validity of the proposed research approach. The great bulk of the references was judged to be relevant, and the search on the whole was considered to be of good quality. It was felt that the general background information requested in this Problem Submission had been satisfactorily answered, and the problem is therefore closed. In the future, however, the Transfer Status of this Problem may be altered should further study of the references prove to be of significant help.

■ WSM-3 Infrared Irradiation of Skin Surface

Communications:

12 November 1968--Messrs. Buck and Berger interviewed the Problem Originator. He stated that he ordered about seven references and, in general, found the search very useful since it turned up applicable papers from nonbiological research of which he was not aware. Three papers, in particular, were of great help: A66-26221, A65-12620, and, most particularly, A63-15343, an RCA report which will be very useful in evaluating thermocouple errors. The Problem Originator stated further that the search results stimulated his thinking, and that the basic papers are increasing his competence in dealing with his problem. The bibliographies found in the papers are also judged to be of help. The basic information sought in the Problem Statement submission has been answered. The problem is considered closed out, although technology transfer documentation may become relevant in the future if references are used more directly.

■ WSM-4A Simultaneous Multistress Effects on the Cardiovascular System

Communications:

13 October 1968--Mr. Buck placed a telephone call to NASA-MSD to follow up on request for astronaut suit loan.

12 November 1968--Messrs. Buck and Berger interviewed Dr. John D. Murray and established that the University of Washington had received the "space underwear" on a second loan from MSD.

■ WSM-5 Techniques for Restricting Blood Flow in the Legs

Communications:

18 October 1968--Mr. Buck visited NASA-Ames (Mr. Galant) and discussed cuff design. Other design features of the proposed special suit (elastic material, inflatable pad, adjustable zippers) were also discussed.

12 November 1968--Consultant informed SwRI that work on this problem is being postponed for approximately 6 months until the Problem Originators have available time to work on it. The problem is on inactive status.

■ NWR-1 Motion Pattern Measurement of Patients

Communications;

13 November 1968--The Problem Originator was interviewed, and he stated that three out of approximately eight documents ordered had recently been obtained, but that he had not as yet had a chance to study the full documents. The one document studied so far appears to have potential value. A search evaluation will be made after the majority of the documents will have been received and studied by the Problem Originator.

■ NWR-2 Pressure Measurement to Aid Prevention of New
Decubitus Ulcers

Communications:

10 October 1968--Relevant abstracts describing computer programs available from COSMIC were selected by Messrs. M. Schrader and L. Berger, and were sent to the Problem Originator for his evaluation.

10 October 1968--Mr. Buck supplied Problem Originator with a new catalog from Stow Laboratories.

25 October 1968--The results of his conference with Messrs. Rositano and Kolbe of the NASA-Ames Instrument Division were forwarded by Mr. Buck to the Problem Originator by way of the Institution Consultant. Literature concerning pressure sensitive paint and pressure cells from a commercial source was made available to Problem Originator.

13 November 1968--Messrs. Buck and Berger interviewed the Problem Originator. It appears that none of the information furnished in conjunction with this problem has materially aided the Problem Originator. This problem, which is of interest to researchers in many parts of the country, has so far eluded satisfactory solution. Since it has been thoroughly investigated, there seems to be no alternative to closing the problem without providing substantial help to the Problem Originator.

20 November 1968--Information concerning SwRI pressure sensitive microcapsule research sent to Problem Originator.

■ NWR-4 Exercise Device for Handicapped or Confined Patients

Communications:

8 October 1968--Dr. R. W. Ware called Dr. A. D. Catterson, Deputy Director of Medical Research and Operations, Manned Spacecraft Center, to follow up on request for information regarding the exercise device. Dr. Catterson stated he believed that the device was either the so-called "Exer-Genie" or a programmed ergometer developed by Collins. This information was forwarded to the Consultant.

10 October 1968--"Exer-Genie" information, obtained through commercial channels, forwarded to Consultant.

13 October 1968--The results of Dr. Ware's inquiry at Manned Spacecraft Center were presented to the Problem Originator by Mr. Buck.

13 November 1968--The Problem Originator, in an interview with Messrs. Buck and Berger, stated that the problem was answered by the "Exer-Genie" device which is currently being used in astronaut training. A Transfer Report is included in this document.

18 November 1968--It was established that the solution to this problem was a commercial development (non-NASA). Mr. J. T. Wheeler, TUO, NASA-MSC, furnished this information via a telephone call to Mr. Berger.

- NWR-5 Numerical Methods for Solutions to Wave Equations in Layered Media of Arbitrary Cross Section

Communications:

7 October 1968--Information furnished by COSMIC on computer program "Shore-Catch," a heat transfer digital computer program, forwarded to Consultant. COSMIC is continuing to search for applicable programs.

13 October 1968--Selected abstracts of computer programs indexed by COSMIC were forwarded from SwRI to the Problem Originator by Mr. Buck.

13 November 1968--Messrs. Buck and Berger interviewed the Problem Originator to get an evaluation of the computer programs which had been selected for study. None of these appears to be well suited for solving the submitted problem, and preparation of a Problem Abstract draft is contemplated.

APPENDIX A

REFERENCES FORWARDED

Ref. No.	Reference Title	Date Sent
<u>General</u>		
AD-424606	Bulletin of Experimental Biology and Medicine (Selected Articles)	2 December 1968
N67-10886	Spectral Analysis Techniques and Pattern Recognition Methods for Electroencephalographic Data	2 December 1968
AD-428600	Methods of the Manual Analysis of Multisource, Continuously Recorded Biomedical Data	2 December 1968
N66-33387	Spectral Analysis Techniques and Pattern Recognition Methods for Electroencephalographic Data	2 December 1968
N68-27724	Final Report National Aeronautics and Space Administration Contract NSR-23-006-041, Wayne State University	2 December 1968
A65-82203	Accuracy of Electrocardiographic Measurements by Computer	2 December 1968
A66-24233	Deterministic Type Waveform Analysis in Electrocardiography	2 December 1968
A66-24231	A Hybrid Computer System for the Measurement and Interpretation of Electrocardiograms	2 December 1968
N66-15117	Autocorrelation Techniques Applied to the Fetal Heart Signal	2 December 1968
A66-14597	Adaptive Signal Reconstruction	2 December 1968
	Complex Signal Analysis Techniques	2 December 1968
	The Adaptive Prediction of Time Series	2 December 1968

Stanford University School of Medicine

REFERENCES FORWARDED

Ref. No.	Reference Title	Date Sent
<u>General</u>		
TB 68-10363	Texas Institute for Rehabilitation and Research Improved Radiographic Image Amplifier Panel for Dr. Peterson	4 November 1968
	Strong and Ductile Steels, <u>Scientific American</u> , No. 1968, Vol. 219, No. 5, sent to Thorkild J. Engen, C.O.	6 November 1968
	<u>Development of Prosthetic Devices</u> , Project #1-424-F, Armour Research Foundation, 16 Oct. 1946	19 November 1968
	Progress Report #2, ARF, January 1, 1947	19 November 1968
	Terminal Research Reports, Committee on Artificial Limbs, National Research Council, June 30, 1947 (Courtesy of A. Bennett Wilson, Jr.)	19 November 1968
	"Chemistry of Hydron, " <u>Hydron Quarterly Review</u> , Vol. 1 #1 sent to Dr. Scott	2 December 1968
<u>HUV-17</u> A68-80548	Method of Kinematic Study of Normal Upper Extremity Movements	30 October 1968
A66-81221	Methods for Obtaining Kinetic Data to Analyze Human Motions	30 October 1968
N64-23428-No. 20	On Methods of Studying Movements Assuring Urgent Information About the Measured Parameters	30 October 1968
N64-32022	Stereoplotter, Projection AP-14	30 October 1968
N64-23428-No. 16	Complex Installation for Studying Coordinations of Movements When Turning Bicycle Pedals	30 October 1968
N64-31588	Feasibility Demonstration of Digital Displacement Sensing Techniques	30 October 1968
A 65-10103	A High-Speed, Inertia-Free Automatic Stereoplotting Instrument	30 October 1968
TB 67-10114	Integrated Mobility Measurement and Notation System	30 October 1968

REFERENCES FORWARDED

General

Ref. No.	Reference Title	Date
	Palo Alto Medical Research	
TB 68-10363	"Improved Radiographic Image Amplifier Panel " forwarded for Dr. Neil Ingels.	28 October 1968
	"A New Device for Recording Cardiac Motion" forwarded for PLR-2	14 October 1968

REFERENCES FORWARDED

Ref. No.	Reference Title	Date
	Northwest Handicapped Center	
	Information on University of California (Berkeley) research received from Professor D. M. Cunningham and forwarded to Mr. Hall, with GM developments; referred to SwRI courtesy of Mr. A. Bennett Wilson, Jr. National Research Council	18 Nov. 1968

REFERENCES FORWARDED

SRS-8A

Ref. No.	Reference Title	Date
TB-68-10065	Multichannel Implantable Telemetry System	11 November 1968
TB 66-10624	Miniature Telmetry System Accurately Measures Pressure	11 November 1968
TB 66-10057	Miniature Bioelectronic Device Accurately Measures and Telemeters Temperature	11 November 1968
TB 64-10171	Subminiature Biotelemetry Unit Permits Remote Physiological Investigations	11 November 1968
TB 64-10025	Improved Electrode Gives High-Quality Biological Recordings	11 November 1968
TB 65-10203	Tiny Biomedical Amplifier Combines High Performance, Low Power Drain	11 November 1968
TB 66-10549	Miniature Electrometer Preamplifier Effectively Compensates for Input Capacitance	11 November 1968
TB 66-10536	Helmet System Broadcasts Electroencephalograms of Wearer	11 November 1968
TB 67-10598	Cardiotachometer with Linear Beat-to-Beat Frequency Response	11 November 1968
TB 67-10669	Ultraminiature Manometer-Tipped Cardiac Catheter	11 November 1968
TB 68-0365	Automatic Patient Respiration Failure Detection System with Wireless Transmission Between Patient and Alarm	11 November 1968
NASA Sp-5021(06)	Cumulative Index to NASA Tech Briefs (1963-1967)	11 November 1968
NASA SP-5021(07)	Index to NASA Tech Briefs, January - June, 1968.	11 November 1968

REFERENCES FORWARDED

Ref. No.	Reference Title	Date Sent
RNV-2		
TB 68-10328	Transistorized Marx Bank Pulse Circuit Provides Voltage Multiplication with Nonosecond Rise-Time	28 October 1968
RNV-10, -11		
NASA CR-1042	Relative Role of Gravitational and Inertial Work in the Energy Cost of Human Locomotion	2 October 1968
RNV-13		
	Sophisticated Light Management Using Development in Fiber Optics	18 November 1968
RNV-16		
TB 68-10365	Automatic Patient Respiration Failure Detection System with Wireless Transmission	28 October 1968

REFERENCES FORWARDED

<u>Ref. No.</u>	<u>Reference Title</u>	<u>Date Sent</u>
	The University of Texas Medical Branch	
	General	
	Brochures on Finnegan Mass Spectrometers	22 November 1968
<u>GLM-15, -17</u>	Information on commercial gas chromatography, especially suitable for respiratory analysis applications, forwarded to consultant	18 November 1968